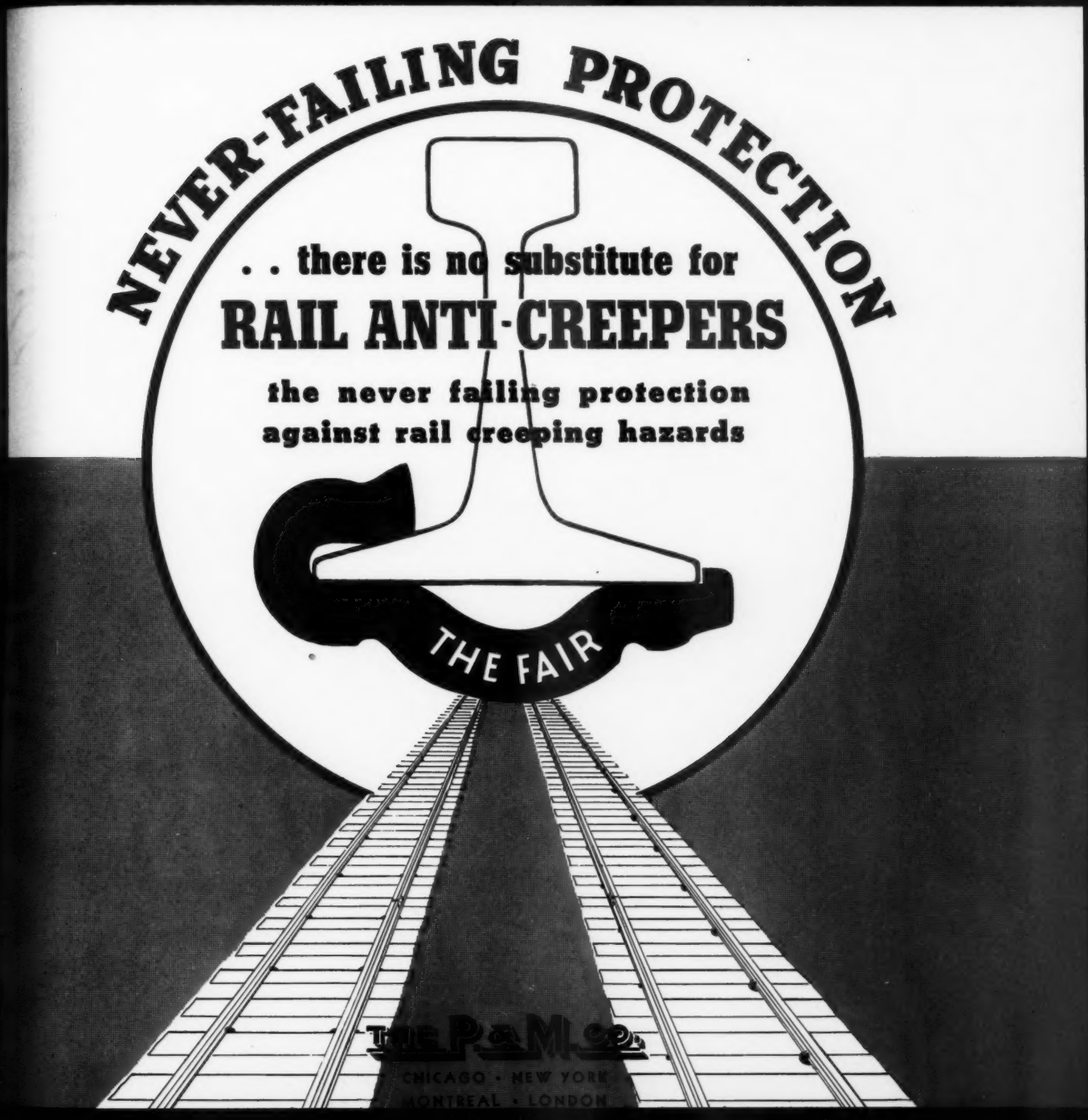
Railway Engineering Maintenance



When

IS A BOLT TIGHT ?

• A bolt should be TIGHT immediately after installation, but tests and research investigations prove LOOSENESS starts to develop at once as wear and stretch occur. This condition ACCELERATES wear unless an automatic device, equal to a Reliance HY-CROME *Spring Washer*, is used. Adequate tension is provided automatically and COMPENSATION for such wear and stretch is available by using HY-CROME *Spring Washers*. There are many devices which keep a nut in PLACE, but a quality spring washer provides additional protection against wear, stretch and looseness which definitely develops in all bolted assemblies—Reliance HY-CROME *Spring Washers* KEEP BOLTS TIGHT and under TENSION.

EATON MANUFACTURING COMPANY

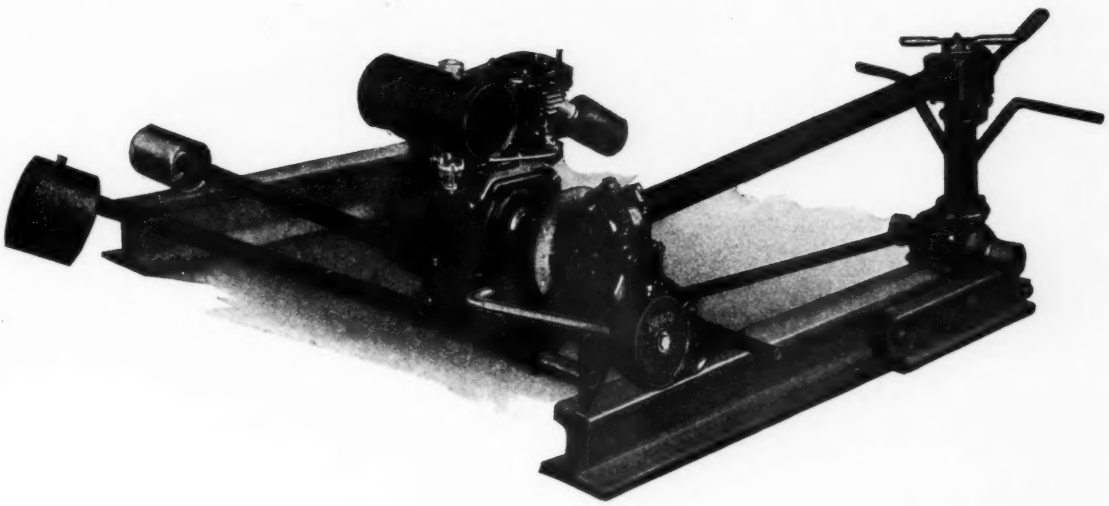
RELIANCE SPRING WASHER DIVISION

MASSILLON, OHIO

Sales Offices: New York, Cleveland, Detroit, Chicago, St. Louis, San Francisco, Montreal

Published monthly by Simmons-Boardman Publishing Corporation, 105 W. Adams St., Chicago, Ill. Subscription price: United States and Possessions, and Canada, $2.00; Foreign, $3.00. Single copies 35 cents. Entered as second-class matter January 20, 1933, at the postoffice at Chicago, Ill., under the act of March 3, 1879, with additional entry at Mount Morris, Ill., postoffice. Address communications to 105 W. Adams St., Chicago, Ill.

Raco Power Track Machine



"Mr. A. says their RPTM's turn out a lot of work–and cheaply. Says they could not get along without them as **they have eliminated a lot of joint trouble, greatly reducing maintenance costs.**"

"He says that though there **is a great saving in tightening by machine,** over hand methods, **still the greater saving, by far, is in reduction of maintenance from former figures.**"

RAILROAD ACCESSORIES CORPORATION

MAIN OFFICE
405 LEXINGTON AVENUE
(Chrysler Building)
NEW YORK

Fight snow before it falls

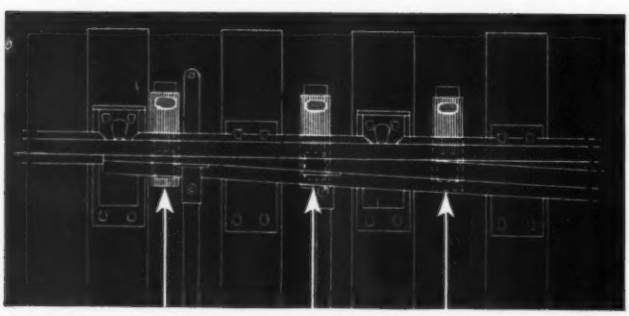
with

BETHLEHEM WINTER KING SWITCH HEATERS

A sliding cover acts as a heat regulator and also protects wick chamber when not in use.

Fuel opening is protected by self-closing cover.

No special filling can is necessary.



General practice is to use three heaters to a side on 10-ft. switches; four to a side on 16-ft. 6-in. switches.

The Winter King switch heater is an inexpensive, kerosene-burning snow melter for turnouts, crossovers and slips. It is effective and efficient; easily installed, easily maintained, and economical as to fuel.

Winter Kings are safer, surer and cheaper than manual snow removal. Their entire cost is often saved in a single blizzard, since one man can light, watch and refuel heaters for from 10 to 25 switches.

Winter Kings have two advantages over other types of snow melters. Their low first cost makes them more economical where only a few bad days can be anticipated. And they are self-contained, suitable for use where electricity, gas or steam is not readily available.

Winter Kings are durable. Normally they are installed in the fall, removed in the spring, but they can be left in place the year 'round. All openings are protected from cinders and dirt. The welded construction, of rust-resisting copper-bearing steel, means long life.

Winter Kings burn from 9 to 15 hours without refilling. In the severest storms, they require refilling only every four to five hours. No special filling can is required and heaters can be refilled while burning.

The durable construction, the separate fuel and wick chambers and the provision for heat-regulation make Winter Kings unusually satisfactory. More than 25,000 are already in service. There are undoubtedly many places on your system where these heaters will keep switches open at a substantial saving in cost. It is not too soon to install them now for protection this winter.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

Years Ahead in Design

FAIRMONT CARS HAVE THE FEATURES WHICH SERVE YOU BEST

THE NEW *Fairmont* HY-DUTY TIMER

Peps Up Performance Of New Cars and Old

Performance ON THE JOB COUNTS

Quicker response to throttle control, smoother performance, and increased power are only a few of the advantages resulting from the use of a FAIRMONT Hy-Duty timer. This new, efficient spark regulator is standard equipment on all FAIRMONT cars and can be easily applied—without pulling the flywheel—to earlier engines that have wiping block operated timers.

The mounting casting of the timer is in two halves, bolted together for easy installation. The upper part of the timer, or body casting, contains the long, double leaf spring blade; the condenser; the contact point; and the adjustable arc of contact screw. This improved timer is the result of FAIRMONT'S continual pioneering for greater motor car efficiency and economy. Write for details.

Fairmont Railway Motors, Inc., Fairmont, Minnesota

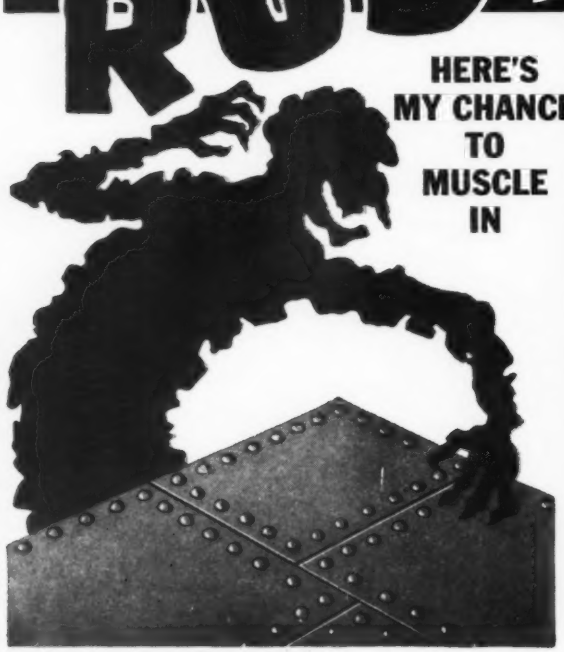
OUTSTANDING ADVANTAGES

1. Smoother Operation.
2. Easily Adjusted Rubber Mounted Contact Point.
3. Length of Arc of Contact Is Easily Changed Without Readjusting Contact Points.
4. Cast in 2 Pieces for Easy Installation.
5. A Better Spark at Lower Voltage.
6. Fuel Economy.

OF ALL THE CARS IN SERVICE TODAY

More Than Half are Fairmonts

RACKETEER RUST DISCOVERS THAT CRIME DOESN'T PAY



DUTCH BOY RED-LEAD

In the fight against Rust, Dutch Boy Red-Lead has a record to be proud of. On millions of square feet of metal surfaces—in every major American industry—this paint is on guard to prevent Rust from levying tribute. So no one can be called an experimenter—or a chance taker—when he specifies Dutch Boy Red-Lead.

First and foremost, this paint has "stick-to-itiveness." It takes hold and holds fast. At the same time, it is highly elastic—expansion or contraction of the metal surface does not loosen its grip. It not only keeps out moisture but also resists the destructive action of other common causes of corrosion—such as gases, smoke and salt water.

Dutch Boy Red-Lead comes in both paste and liquid form, the latter including a quick-drying type for use when allowable drying time is short. The pigment in every case is pure red-lead that contains more than 97% Pb_3O_4, thus assuring easier application, higher spreading rate and a uniform film of greater density.

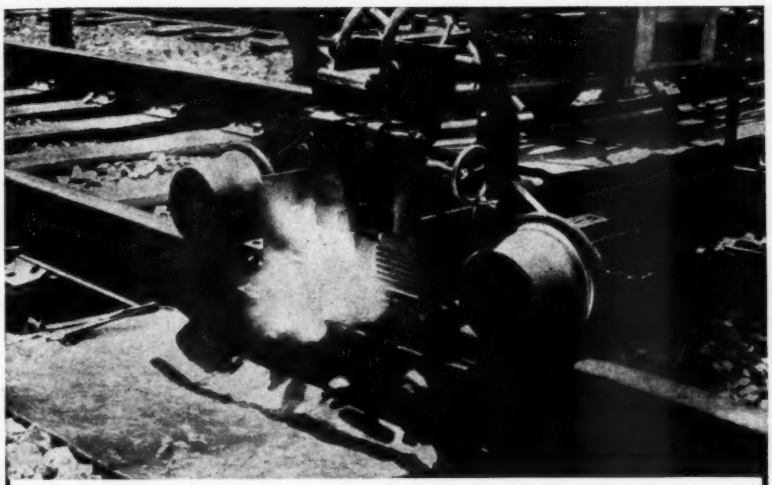
For long service, and complete dependability, specify Dutch Boy Red-Lead.

NATIONAL LEAD COMPANY

111 Broadway, New York; 116 Oak St., Buffalo; 900 West 18th St., Chicago; 659 Freeman Ave., Cincinnati; 1213 West Third St., Cleveland; 722 Chestnut St., St. Louis; 2240 24th St., San Francisco; National-Boston Lead Co., 800 Albany St., Boston; National Lead & Oil Co. of Penna., 316 Fourth Ave., Pittsburgh; John T. Lewis & Bros. Co., Widener Building, Philadelphia.

Oxweld Railroad Service TOPICS

1912 — OVER A QUARTER CENTURY OF SERVICE TO AMERICAN RAILROADS — 1939



OXWELD RAIL-END HARDENING

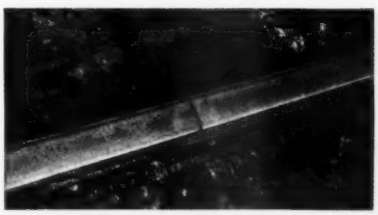
Economical, Efficient, and Easily Done

End-hardening of all new rail to postpone batter is now standard practice on most railroads. The Oxweld method provides one of the most economical, efficient, and convenient means of rail-end hardening. The initial cost is low and the resulting savings in joint maintenance expense are substantial. This method permits the uniform production of adequate hardness for the rail service requirements. The work can be readily performed in track without interrupting traffic and without tying up railroad equipment.

AS GOOD AS NEW

After 4 1/2 years

The rail ends shown in the illustration were hardened by the Oxweld method early in 1935. They have been in service ever since in busy main line track and show no sign of end or secondary batter. Rail ends hardened by Oxweld five and six years ago are now as level and free from unevenness as newly-laid rail. Indications point to the strong probability that these rail



ends will wear evenly with the balance of the rail and will require no special attention during the entire rail life. The heat-treating pattern is still visible.

• BRIEFS •

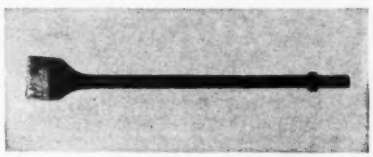
Butt-Welded Rail — Smooth-riding, clickless track and the elimination of signal bonds and joint maintenance are among the advantages of butt-welded rail which can be obtained with the Oxweld Automatic Pressure-Type Rail Welding Process.

• • •

Building-Up Rail Ends — Reduced wear on joint bars and ties and longer life for rail are among the factors which contribute to lowered maintenance costs when battered rail ends are built up by oxy-acetylene welding.

• • •

Hard-Faced Tamper Bars — It has been found that tamper bars hard-faced with Haynes Stellite alloy have 2 to 3 times the normal service life. The hard-facing rod is applied at the end of the



bar in a band about 2 inches wide. A newly hard-faced tamper bar is shown.

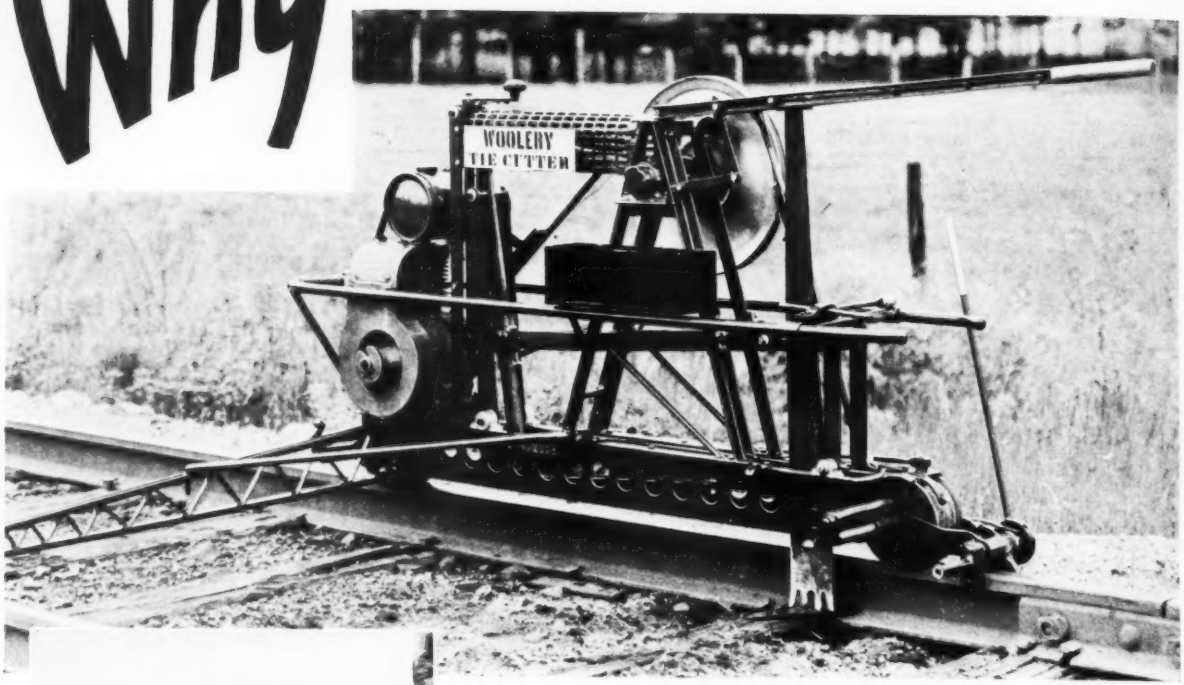
• • •

In addition to bringing to railroads the oxy-acetylene process applications described on this page, Oxweld Railroad Service provides for installing welded signal bonds, reclaiming worn joint bars, rebuilding frogs and switch points, and Unionmelt welding. For complete information on any of these operations, consult The Oxweld Railroad Service Company, Unit of Union Carbide and Carbon Corporation, Carbide and Carbon Building, Chicago and New York.

OXWELD RAILROAD SERVICE

The words "Haynes Stellite," "Oxweld," and "Unionmelt" are registered trade-marks of Units of Union Carbide and Carbon Corporation.

Why take out a tie prematurely?



If the usual method of digging out the crib had been employed to renew this tie, the tie at the right may also have been taken out this year. The use of the Woolery Tie Cutter permits this tie to render another year's service.

The WOOLERY TIE CUTTER

PROMOTES INCREASED LIFE of TIES by removing the temptation to renew a tie a year or two before its *service life* is finished, as so often occurs when ties are DUG IN.

With the Woolery machine, ties are renewed WITHOUT DIGGING OUT the CRIB. The extra labor and time involved in crib-cleaning, and the consequent urge to take out a *serviceable* adjacent tie in order to save opening up the crib again a year or two later, are thus eliminated.

The Woolery Tie Cutter simply cuts the old tie in three pieces, which are easily lifted out. The crib remains practically undisturbed, and little or no tamping is required after the new tie is pulled in place. Ask for a demonstration—Write for 12-page descriptive Booklet.

INCLUDE WOOLERY TIE CUTTERS in YOUR 1940 BUDGET. They will insure a 30% REDUCTION in TIE RENEWAL COSTS NEXT YEAR, and also COMPLETE the WORK 30% FASTER.

WOOLERY MACHINE COMPANY

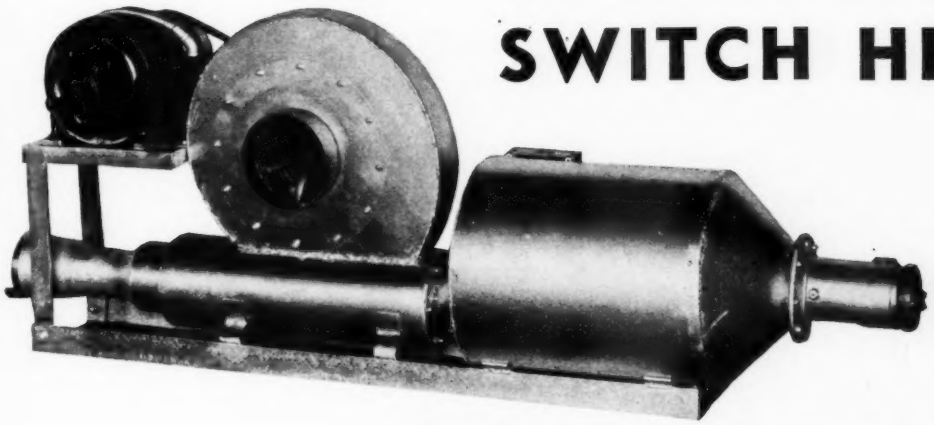
MINNEAPOLIS Pioneer Manufacturers of MINNESOTA

RAILWAY MAINTENANCE EQUIPMENT

TIE CUTTERS • SWITCH HEATERS • MOTOR CARS

RAILWAY WEED BURNERS • BOLT TIGHTENERS

Introducing *the* WOOLERY SWITCH HEATER

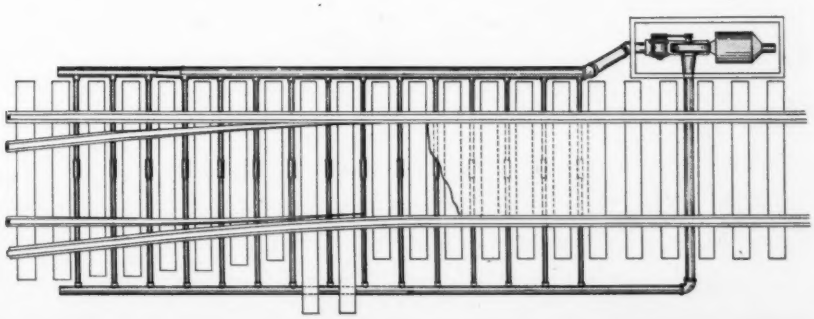


DEPENDABLE-SAFE-ECONOMICAL

Clear the way this winter with the Woolery Switch Heater—a new and improved method of overcoming the hazards of snow and ice-bound switches.

This outstanding development heats and clears the entire switch—not just the points—by forcing hot air from a compact oil burner through a closed system of pipes located beneath the switch. The oil burner and blower are started by an electric control, which can be remotely located. Heating begins immediately regardless of weather conditions.

Operating and maintenance costs are low—there is no open flame—no protruding pipes or wires—no freezing when not in operation. *Now is the time* to investigate—make your installations *before* bad weather gives you trouble.



Right: Piping arrangement for a typical installation. A mixture of hot air and exhaust gases is forced from the Switch Heater, shown at the upper right of the drawing, into an insulated header pipe from which lateral pipes carry the heat to a return header pipe, thence back to the heating unit. Continuous, efficient heat transference is thus assured.

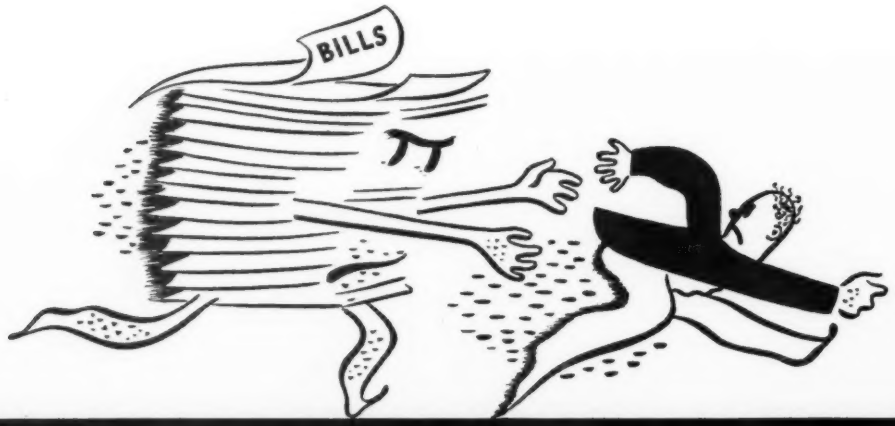
WOOLERY MACHINE COMPANY

MINNEAPOLIS — Pioneer Manufacturers of — MINNESOTA

RAILWAY MAINTENANCE EQUIPMENT

TIE CUTTERS • SWITCH HEATERS • MOTOR CARS

RAILWAY WEED BURNERS • BOLT TIGHTENERS



IT'S TIME TO crack down ON MAINTENANCE COSTS

YES, IT CAN BE DONE. You can reduce maintenance expense, add years to the life of your roadbeds and make them safer and smoother to ride on.

How? By eliminating troublesome frost heaves, water pockets and soft spots *once and for all.* Surface treatment alone won't do the job. For, almost without exception, you'll find that rough track is caused by a wet unstable subgrade. So naturally, the only permanent way to end the trouble is to drain the water out of the subgrade—and keep it out. You can do this easily and economically with ARMCO Perforated Pipe.

In hundreds of similar cases where ARMCO Perforated Pipe has been installed roadbeds have stayed dry and firm the year round. Moreover these installations have paid for themselves in a short time through savings in maintenance. Call or write our nearest office for specific information. ARMCO Railroad Sales Co., Middletown, Ohio. District offices are in the following cities: Berkeley, California • Chicago, Ill. Cleveland, Ohio • Denver, Colorado • Houston, Texas • Minneapolis, Minnesota • New York, New York • Philadelphia, Pa. • Richmond, Virginia • St. Louis, Mo.

As you see here, ARMCO *Perforated Pipe can be installed easily and quickly by the* ARMCO *Jacking Method. This way you eliminate costly "slow orders" and assure greater safety for workmen.*

ARMCO PERFORMED PIPE

A TYPE OF PRODUCT ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

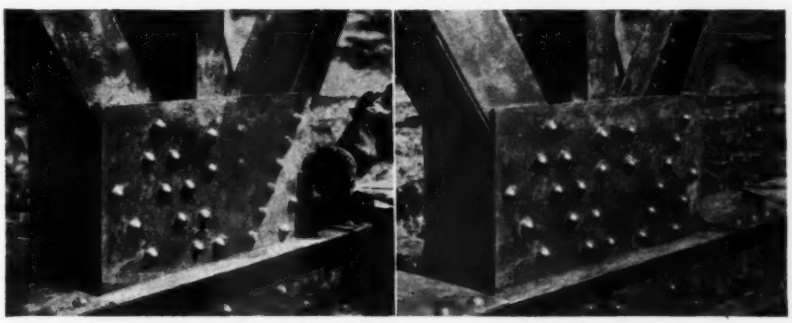
Halt deterioration OF OLD BRIDGE STRUCTURES

THE AIRCO WAY

Built in 1907 for service over the old Erie Canal cut, Rochester, N. Y., this bridge was dismantled and stored out-of-doors for five years. It is now being reconditioned for re-erection elsewhere. » » » This Airco oxyacetylene process cockles old paint, frees rust and scale, drives off moisture and, after power wire-brushing, leaves a warm, clean, dry surface beneficial to a lasting paint job. Write for your copy of "Flame Cleaning and Dehydrating—the Paint-burning and Surface-conditioning of Old Steel Structures."

1. Close-up showing condition of surface prior to surface conditioning.

2. Airco Flame Cleaning and Dehydrating Process Paint-burning. Speedy results with round tip for rivet heads and irregular surfaces and flat tips for plane surfaces.



3. Power wire brush removing loose rust and scale and cockled paint.

4. Full Airco-process Paint-burned and surface-conditioned ready for repainting.

AIR REDUCTION

SALES COMPANY

General Offices: 60 EAST 42nd ST., NEW YORK, N. Y. DISTRICT OFFICES IN PRINCIPAL CITIES

AIRCO *Anything and Everything for* GAS WELDING or CUTTING and ARC WELDING WILSON

The economical performance of CP Two-Stage Air-Cooled Portable Compressors and the low air consumption of CP Tie Tampers are establishing low cost records for track maintenance.

CP Portable Compressors are available in capacities from 60 to 315 cu. ft. per min.; Crawler type; flanged wheel mounted (self-propelled or non-self-propelled); gasoline or Diesel driven.

Noted for its low air consumption, CP 3-D Tie Tamper is ideal for "nipping" and on small rises, as well as for tamping jobs where the track is raised several inches.

Send for a copy of Bulletin SP 1943 describing the complete line of CP Equipment for Maintenance of Way.

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 6 EAST 44TH STREET, NEW YORK, N.Y.

SALES OFFICES AND SERVICE STATIONS THROUGHOUT THE WORLD

CP EQUIPMENT
FOR MAINTENANCE OF WAY

THE ARCHITECTS had a plan for waterproofing the foundations of the new building, but Mr. Thompson was against the idea. That finished that.

A FEW DAYS LATER, a great hubbub started around the building across the street. Crews of workmen were ripping up concrete, shoveling out earth and exposing the foundations on all sides of the building. This went on for days.

Obviously, a big and expensive job.

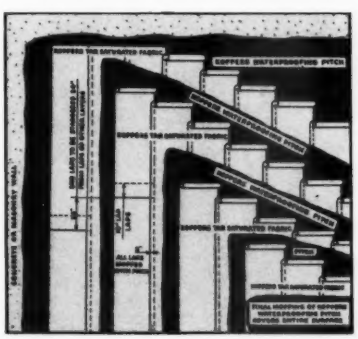
"WHAT'S GOING ON over there?" Mr. Thompson asked.

"The foundations were leaking," said his assistant. "They had to dig up the ground and apply waterproofing."

"Waterproofing?" said Mr. Thompson, grabbing his hat. "I'm going over."

THE HEAD of the company across the street told Mr. Thompson the whole sad story. Water getting through the foundations. Damaging machinery. All sorts of remedies tried, but finally the decision that nothing but Koppers Tar Membrane Waterproofing on the water side of the foundations would do.

BACK IN his office, Mr. Thompson sent for the architect again. "I've changed my mind," he said, "Maybe we had better do something about waterproofing that new building of ours."



THE FOUNDATIONS of the building are tightly encased in a strong, elastic, continuous blanket of Koppers Tar Waterproofing Pitch and Tar-Saturated Fabric.

THE FOUNDATION is dry. The machinery is completely protected against water. The concrete is safe from elements in the soil which might cause it to deteriorate. Koppers Tar Membrane Waterproofing, being properly applied, also makes the building termite-proof.

ROOFING—The ability of Koppers Coal Tar Pitch to resist prolonged contact with water (which makes it so valuable for waterproofing) also makes Koppers Coal Tar Roofing Pitch so trouble-free and long-lived. Specify Koppers Coal Tar Pitch and Felt for your roofs.

OTHER KOPPERS PRODUCTS

Roofing . . . Bituminous-base Paints . . . Tarmac Road Tars . . . Pressure-treated Timber Products . . . American Hammered Piston Rings . . . Bronze Iron Cylinder Packing . . . Coal . . . Coke . . . Fast's Self-aligning Couplings . . Koppers D-H-S Bronze . . Engineering and Construction Work . . Material-handling Equipment

KOPPERS COMPANY · PITTSBURGH

a KOPPERS product

Modern Trains need Modern Roadbeds

TONCAN PRODUCTS HELP PROVIDE THEM

Toncan Drainage Products meet all the requirements of modern railroading for structures that are permanent, low in maintenance, quickly installed, and thoroughly dependable. Practical suggestions for the best solution to your bridge or drainage problems can be obtained from Toncan Culvert Manufacturers' Association, Republic Building, Cleveland, Ohio.

TONCAN CORRUGATED METAL PIPE

A Standard Drainage Structure for 35 Years. Made of rust-resisting Toncan Copper Molybdenum Iron with 2-oz. zinc coating. • Supplied in diameters from 6 to 84 inches, in any length, in multiples of 2 ft., and in 16 to 8 gauge depending on diameter of pipe. • Complete stock including connecting bands, tees, ells, crosses,— available at various shipping points for immediate delivery.

TONCAN PERFORATED METAL PIPE

A Drainage Product which is quickly and easily installed and assures efficient underdrainage with negligible maintenance cost. • Perforated before galvanizing. • Supplied in diameters from 6 to 30 inches, in any length, in multiples of 2 ft. and in 16 or 14 gauge depending on diameter of pipe. • Complete stock including fittings available from various shipping points.

TONCAN CORWEL SUBDRAINAGE PIPE

A New Type of Pipe designed for stabilizing soils through subdrainage. Helically corrugated and perforated before hot-dip galvanizing. • Supplied in 6 inch diameter in 18 or 16 gauge. • Available in any length up to and including 24 ft., in either perforated or non-perforated type. • Complete stock including fittings available from various shipping points or from Canton, Ohio.

TONCAN SECTIONAL PLATE PIPE

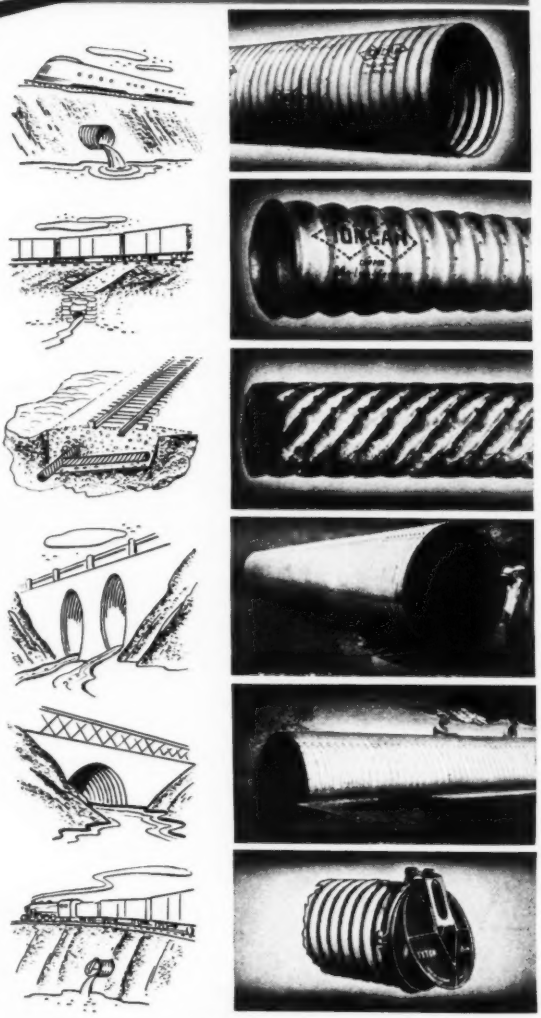
Suitable for large drainage structures. • Corrugations measure 6 inches from crest to crest, 1½ inches in depth. Special bolts furnished. • Diameters from 60 to 210 inches in 7½" intervals and any length in multiples of 2½ ft. • Gauges of 7, 5, 3, 1, or any combination. • Plain, skewed or sloped ends. • Erection plans furnished. • Immediate shipment from Canton, Ohio.

TONCAN SECTIONAL PLATE ARCHES

Provide for durable and attractive small bridges at low cost. • Available in wide range of spans and rises fabricated to meet field conditions. • Supplied in any length, in multiples of 2½ ft., in 7, 5, 3, or 1 gauge or in any combination of these gauges. Plain, skewed or sloped ends. • Complete erection plans furnished. • Immediate delivery from Canton, Ohio.

TYTON FLOOD GATES

A scientifically designed gate which permits flow of water in only one direction. • Designed to fit corrugated metal pipe or may be attached to concrete, stone or other types of headwalls. • Available in 8 to 36 inch diameters on order.



EMBLEM OF QUALITY AND SERVICE •

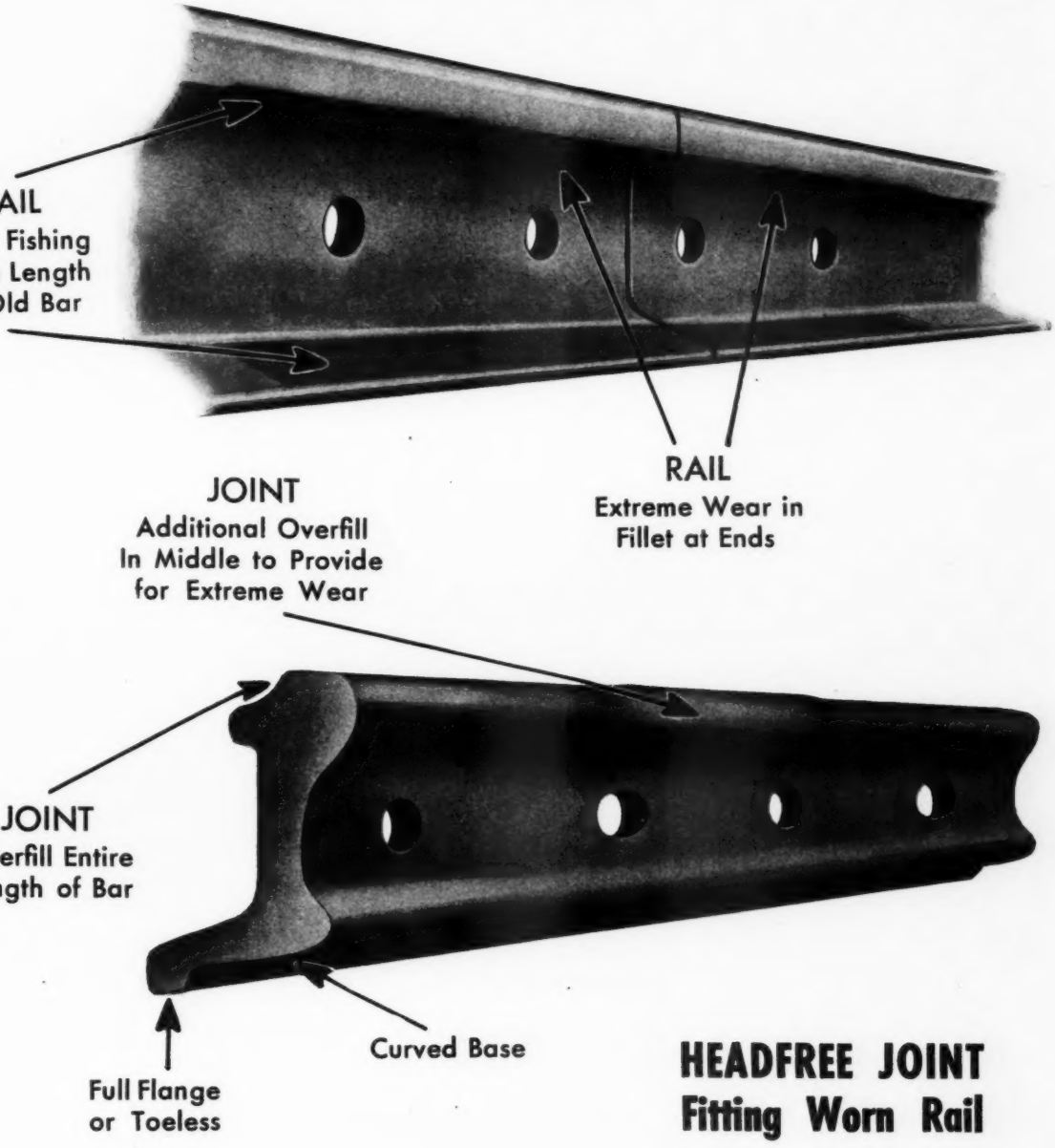
TONCAN CULVERT MANUFACTURERS' ASS'N. MEMBER TONCAN

TONCAN DRAINAGE PRODUCTS

Made of Toncan Iron, an alloy of refined open-hearth iron, copper and molybdenum —that grows old slowly

TONCAN IRON—A PRODUCT OF REPUBLIC STEEL CORP.

NEW JOINTS FOR OLD RAIL



HEADFREE JOINT
Fitting Worn Rail

We Will Gladly Make a Study of Your Track Conditions

THE RAIL JOINT COMPANY INC.

50 CHURCH STREET — NEW YORK, N. Y.

TO RAILWAY SUPPLY MANUFACTURERS

"At the Top of the List"

"Bill, your sales are running below those of last year. What's the reason?" asked the sales manager.

"Boss, that's easy," replied the railway sales representative. "The roads aren't buying."

"Is that so? Don't you know that in the first six months of 1939 they bought over $97,000,000 more materials and equipment, other than fuel, than in the same period last year?"

"Yes, but—"

"Wait a minute. Don't you know also that the railways spent $24,000,000, or over 12 per cent *more,* for the maintenance of their roadway and structures so far this year?"

"But, Boss—"

"And don't forget that more than half this increase is for materials. That's at the rate of $80,000 *more for materials* every working day. Now what's your answer."

"That's a tough one, Boss, but I know they're not buying *our* kind of material."

"Whose fault is it?"

"I'll tell you what the chief clerk to one chief engineer told me last week. He said that his boss reads his copy of *Railway Engineering and Maintenance* from cover to cover every month and makes notes all through the magazine about materials he sees advertised there."

"Well, there's nothing unusual about that."

"That's what I told the chief clerk, but he said that he noticed that these materials seemed to stand near the top of his chief's list all the time. He reckoned the constant repetition serves as a reminder."

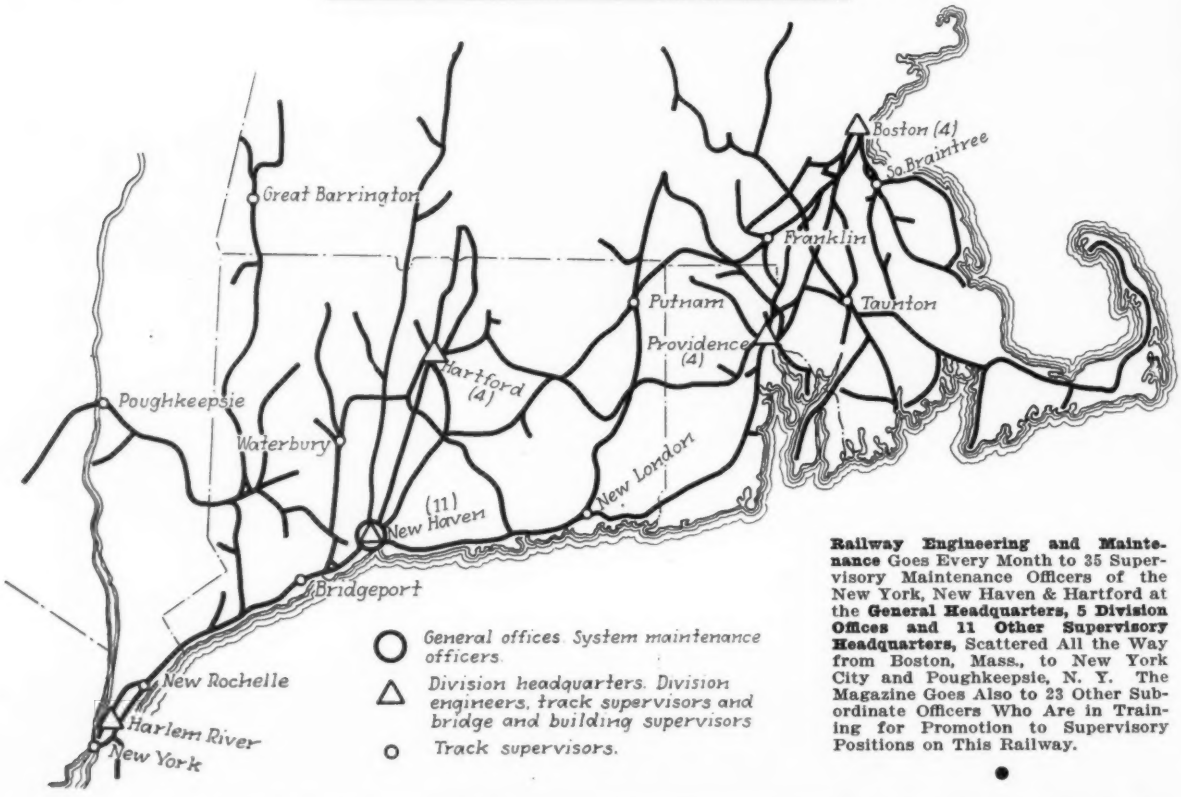
"You mean that he forgets about our material?"

"That's what the chief clerk thinks. And I'm not sure but that he's right."

"You think that we ought to advertise then to keep our products before him?"

"That's it, Boss, and in the magazine these men read, so they'll have our products fresh in their minds whenever they get some money to spend."

"I believe you're right. We'll do it."



Railway Engineering and Maintenance Goes Every Month to 35 Supervisory Maintenance Officers of the New York, New Haven & Hartford at the **General Headquarters, 5 Division Offices and 11 Other Supervisory Headquarters,** Scattered All the Way from Boston, Mass., to New York City and Poughkeepsie, N. Y. The Magazine Goes Also to 23 Other Subordinate Officers Who Are in Training for Promotion to Supervisory Positions on This Railway.

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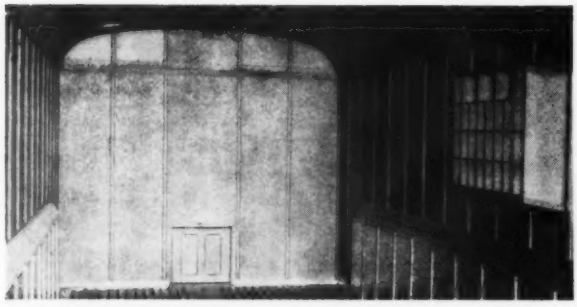

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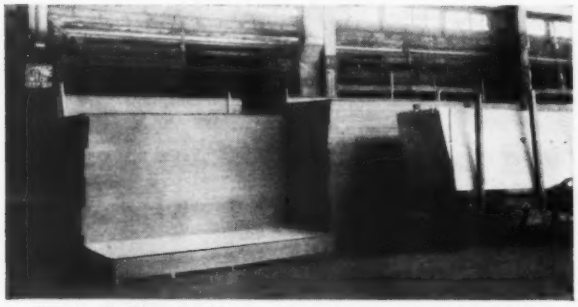

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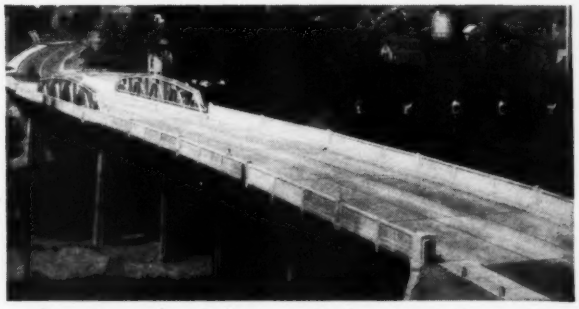

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GENUINE DOUGLAS FIR PLYFORM Concrete Form Panel D F P A
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GENUINE PLYSCORD SHEATHING D F P A
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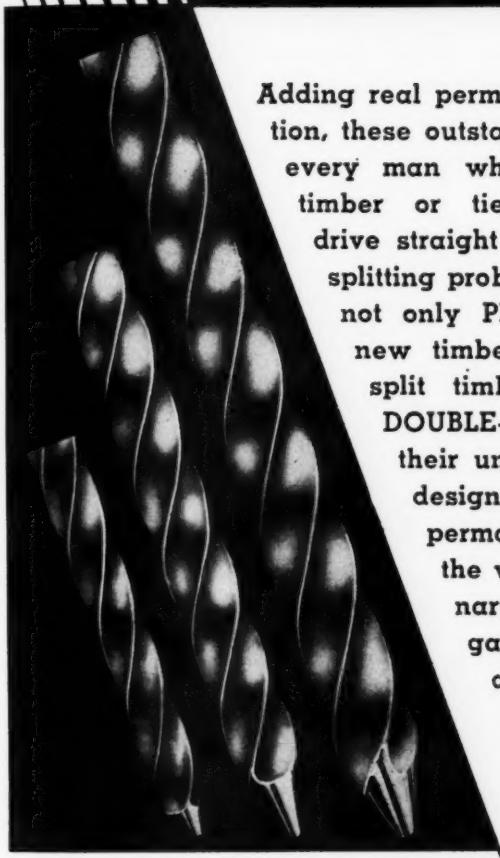

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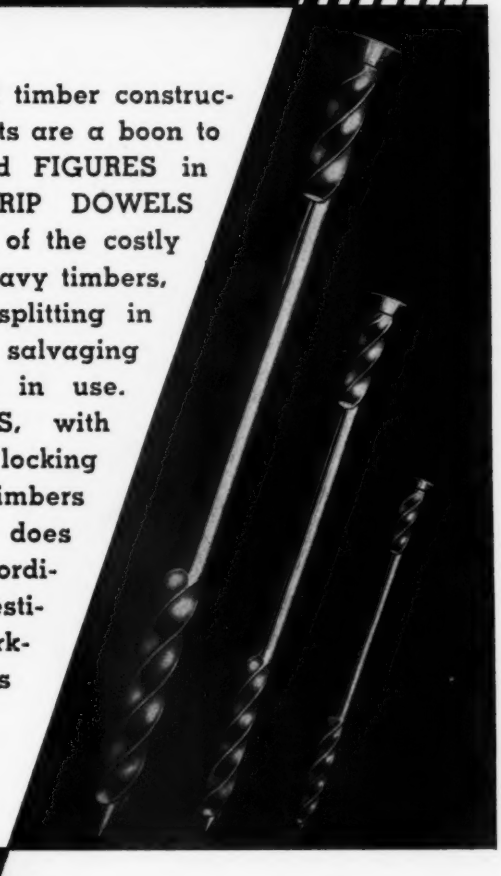

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REINFORCING
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Double-Grip Spikes

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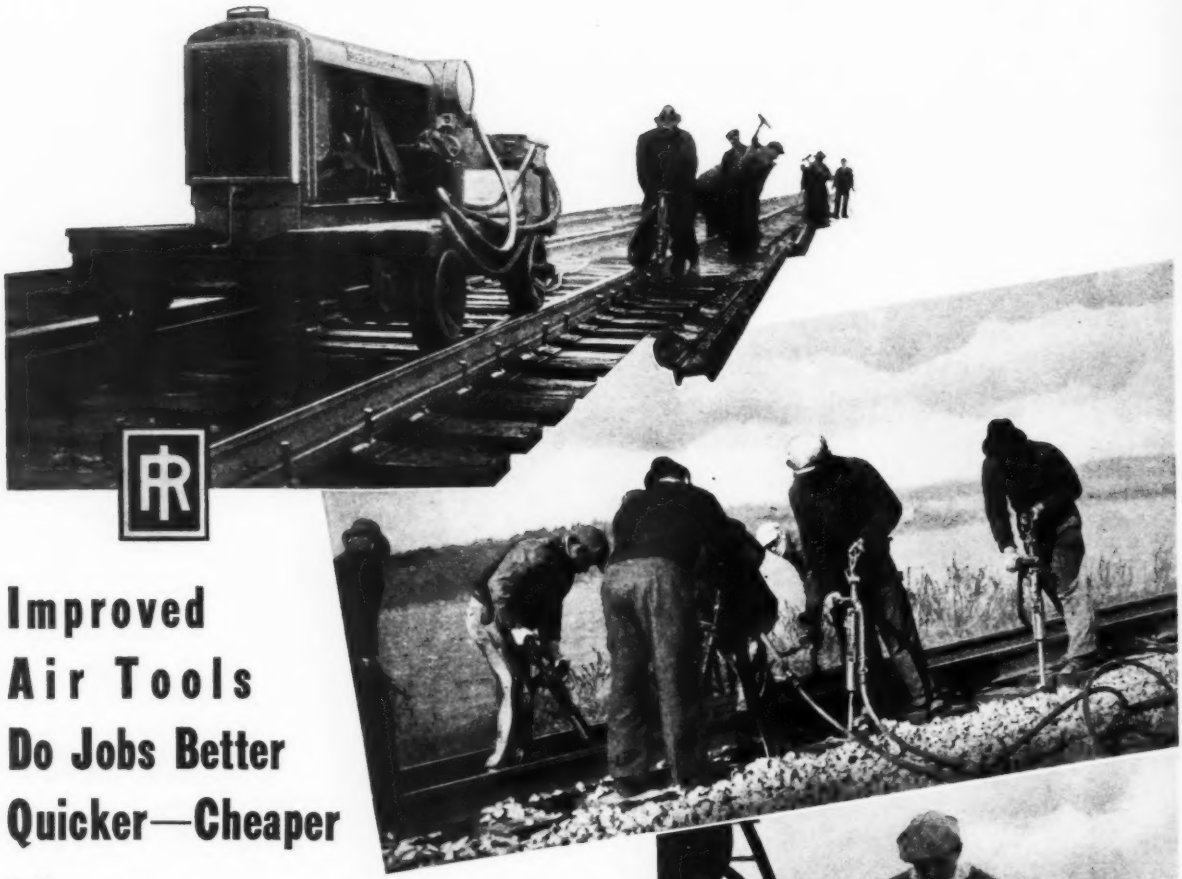
For All Around Track Maintenance



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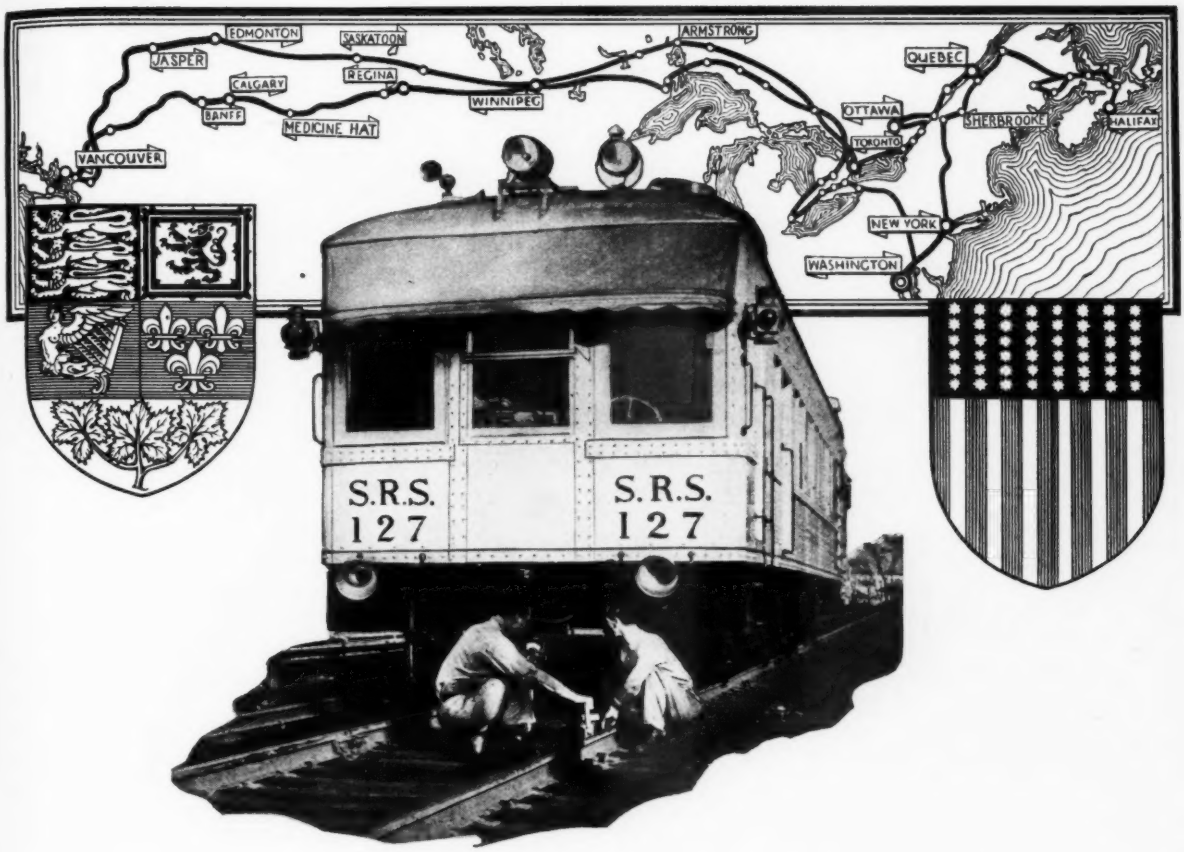

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These figures fail to substantiate the contention that the purchases of the eastern railways are increasing less than those in the west; on the contrary, they show that these roads are actually spending more liberally, as compared with last year, than the railways of the west or of the country as a whole.

The difficulty does not lie, therefore, in any marked difference in purchasing activity. It must rest elsewhere. Possibly it may come back to the sales activities of the manufacturer in question, and of those who share his views. Is he failing to meet the competition of his field for the business that is being placed? Has he rebuilt his sales organization since the depth of the depression in 1932? Have the years of light business taken the fight out of his sales staff?

These are days of streamline activities – in sales organizations as well as in passenger train operations. The public responds to such measures. There is business to be had. The railways spent $103,000,000 more for materials, equipment and fuel for all departments in the first half of 1939 than in the same months of 1938. They spent $23,728,626 more for maintenance of way. Somebody's getting it.

Yours sincerely,

Elmer T. Howson

ETH:EW

Editor

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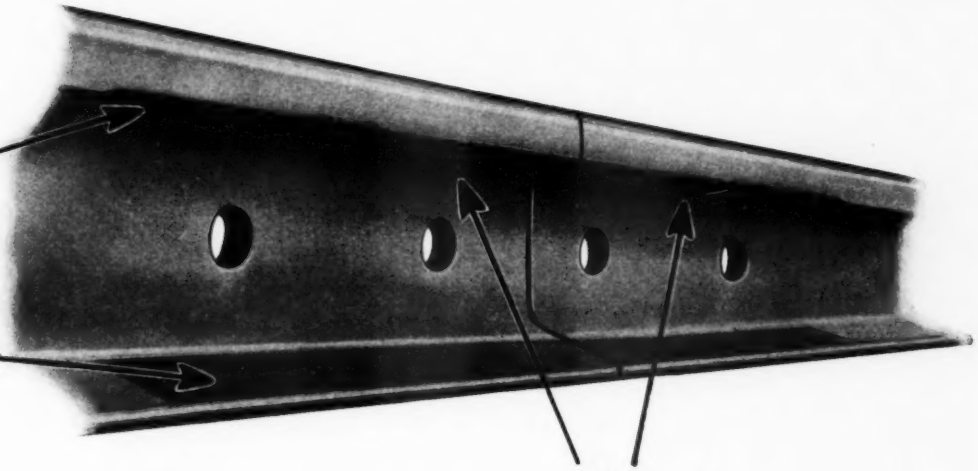
NEW JOINTS FOR OLD RAIL



HEADFREE JOINT
Fitting Worn Rail

We Will Gladly Make a Study of Your Track Conditions

THE RAIL JOINT COMPANY INC.

50 CHURCH STREET NEW YORK, N. Y.

TO RAILWAY SUPPLY MANUFACTURERS

"At the Top of the List"

"Bill, your sales are running below those of last year. What's the reason?" asked the sales manager.

"Boss, that's easy," replied the railway sales representative. "The roads aren't buying."

"Is that so? Don't you know that in the first six months of 1939 they bought over $97,000,000 more materials and equipment, other than fuel, than in the same period last year?"

"Yes, but—"

"Wait a minute. Don't you know also that the railways spent $24,000,000, or over 12 per cent *more,* for the maintenance of their roadway and structures so far this year?"

"But, Boss—"

"And don't forget that more than half this increase is for materials. That's at the rate of $80,000 *more for materials* every working day. Now what's your answer."

"That's a tough one, Boss, but I know they're not buying *our* kind of material."

"Whose fault is it?"

"I'll tell you what the chief clerk to one chief engineer told me last week. He said that his boss reads his copy of *Railway Engineering and Maintenance* from cover to cover every month and makes notes all through the magazine about materials he sees advertised there."

"Well, there's nothing unusual about that."

"That's what I told the chief clerk, but he said that he noticed that these materials seemed to stand near the top of his chief's list all the time. He reckoned the constant repetition serves as a reminder."

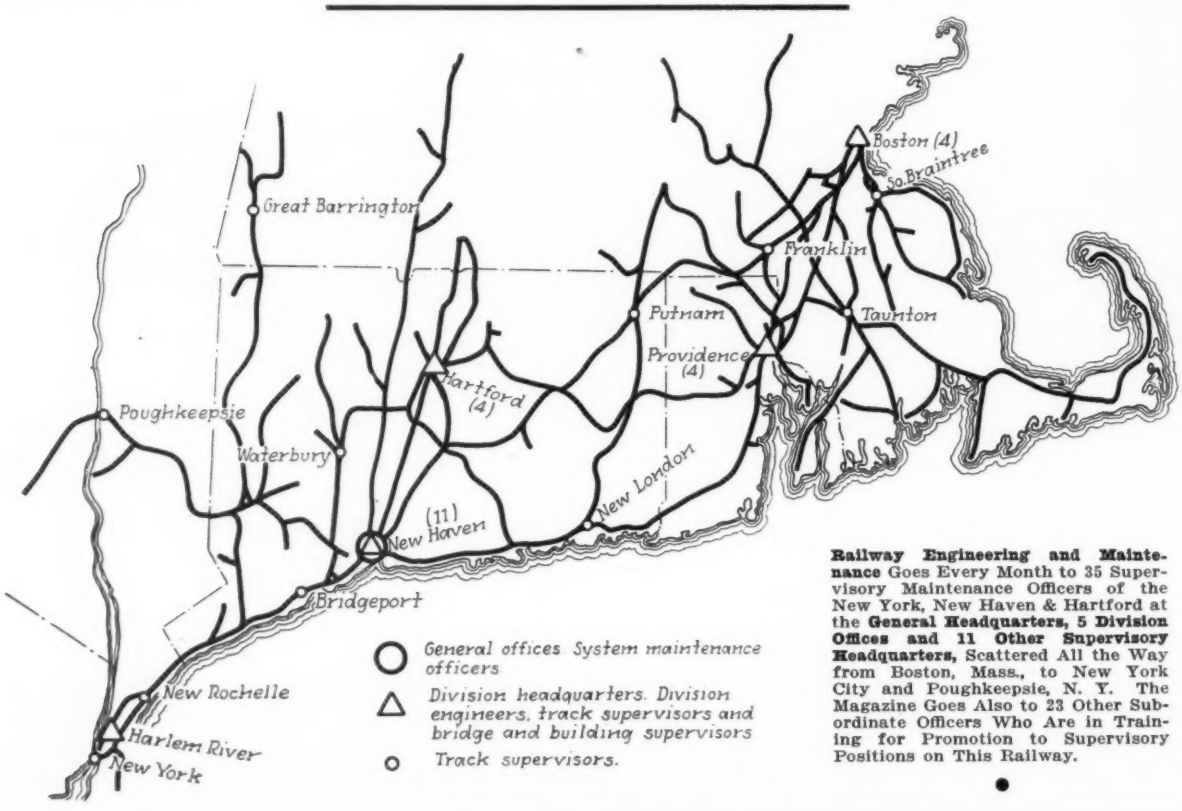
"You mean that he forgets about our material?"

"That's what the chief clerk thinks. And I'm not sure but that he's right."

"You think that we ought to advertise then to keep our products before him?"

"That's it, Boss, and in the magazine these men read, so they'll have our products fresh in their minds whenever they get some money to spend."

"I believe you're right. We'll do it."



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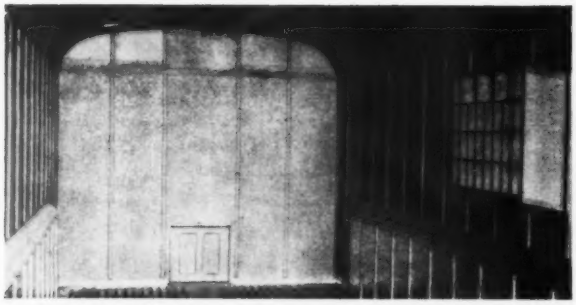

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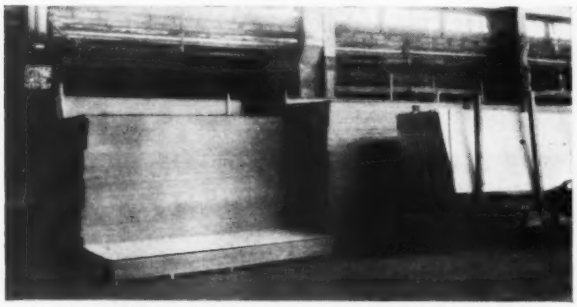

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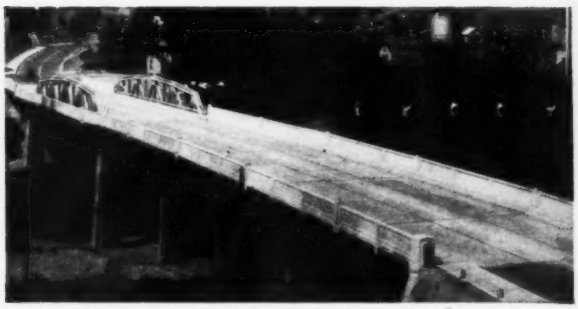

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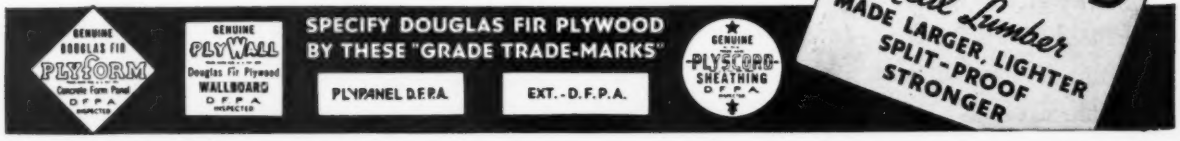

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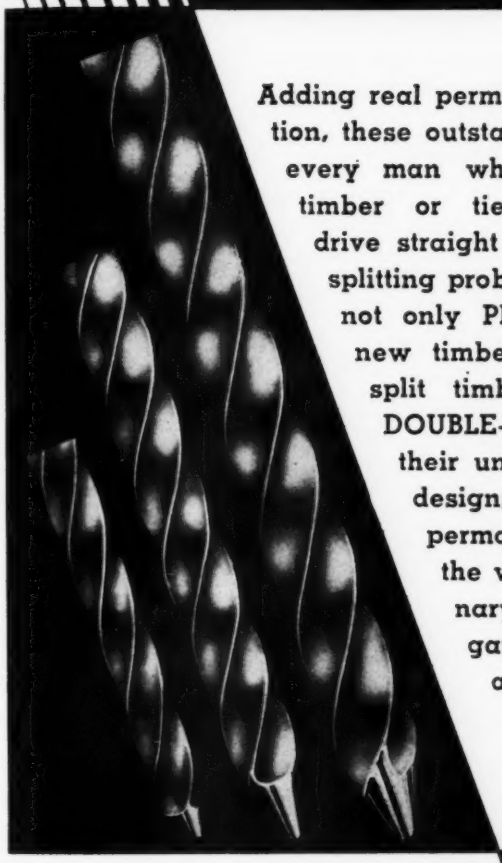

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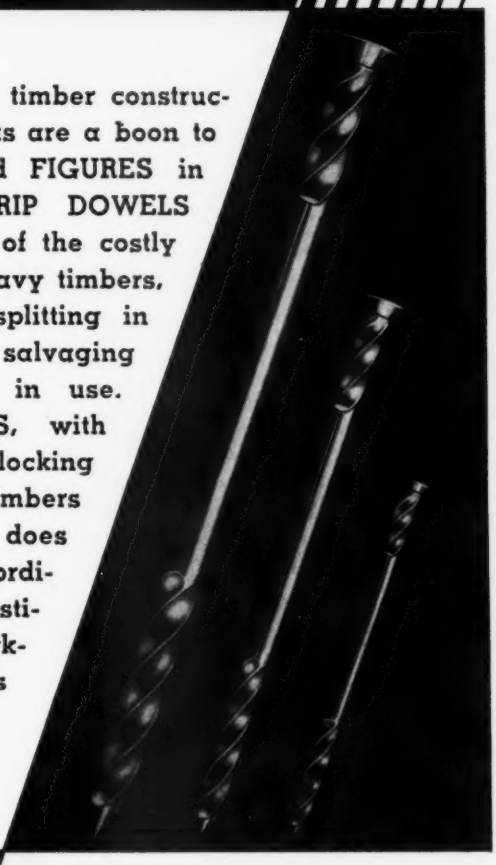

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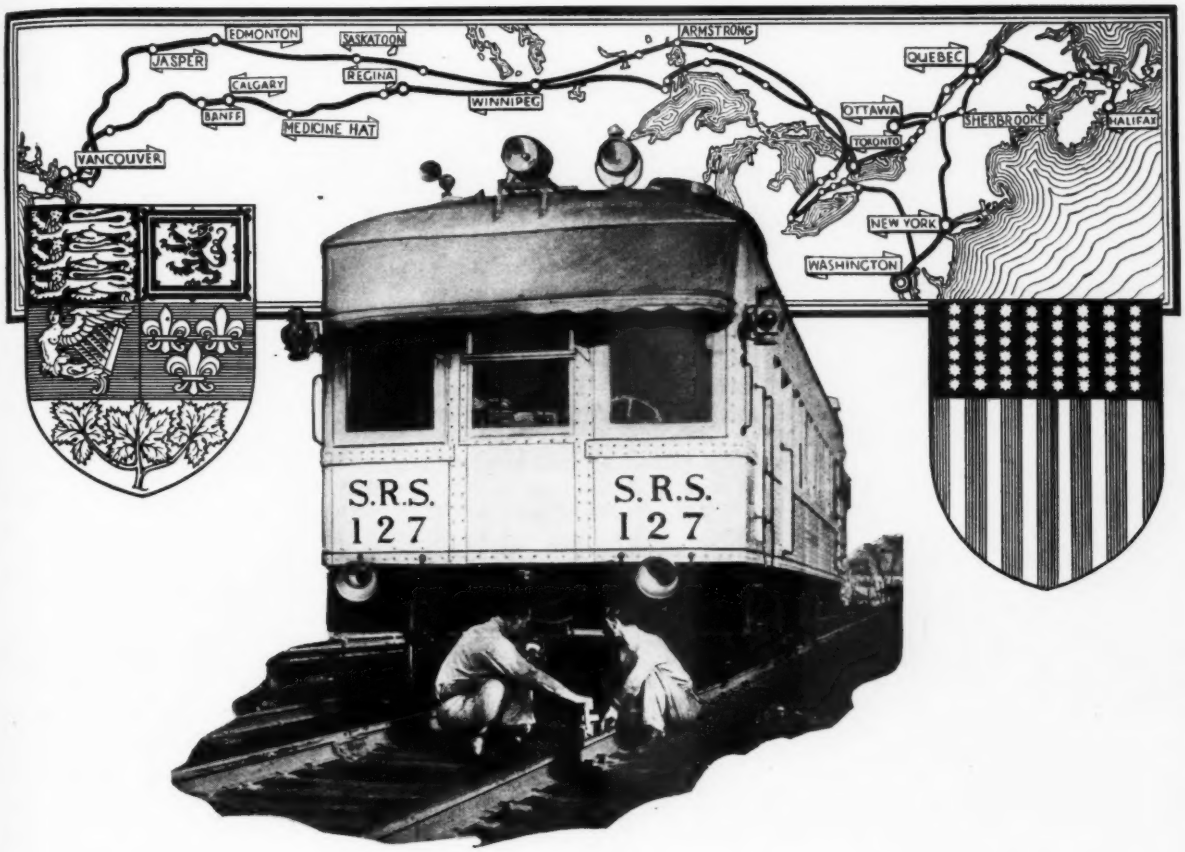

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Western District	85,660,305	96,801,103	13

These figures fail to substantiate the contention that the purchases of the eastern railways are increasing less than those in the west; on the contrary, they show that these roads are actually spending more liberally, as compared with last year, than the railways of the west or of the country as a whole.

The difficulty does not lie, therefore, in any marked difference in purchasing activity. It must rest elsewhere. Possibly it may come back to the sales activities of the manufacturer in question, and of those who share his views. Is he failing to meet the competition of his field for the business that is being placed? Has he rebuilt his sales organization since the depth of the depression in 1932? Have the years of light business taken the fight out of his sales staff?

These are days of streamline activities – in sales organizations as well as in passenger train operations. The public responds to such measures. There is business to be had. The railways spent $103,000,000 more for materials, equipment and fuel for all departments in the first half of 1939 than in the same months of 1938. They spent $23,728,626 more for maintenance of way. Somebody's getting it.

Yours sincerely,

Elmer T. Howson

ETH:EW

Editor

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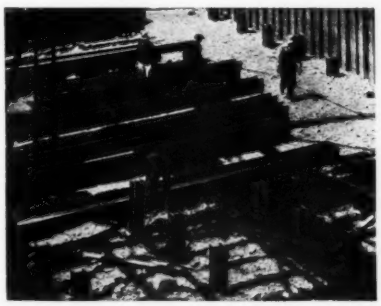

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DOUBLE PURPOSE. Note the perfect alignment and simplicity of this trestle in Clay County, Florida. Here is an effective double-purpose design. U·S·S Steel Bearing Piles act both as bearing piles and trestle bent columns. To withstand flood-borne loads and impacts and lateral shocks, experience dictates the choice of U·S·S Steel Bearing Piles.

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OCTOBER, 1939

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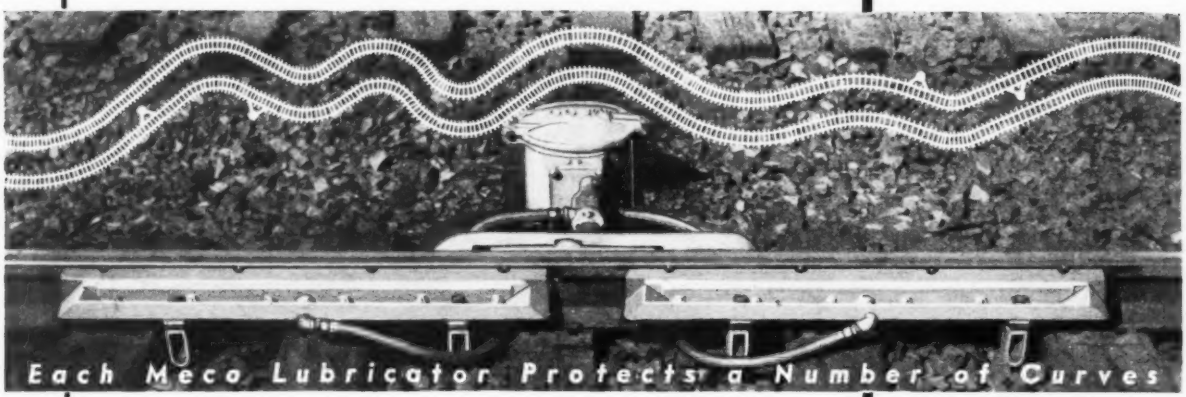

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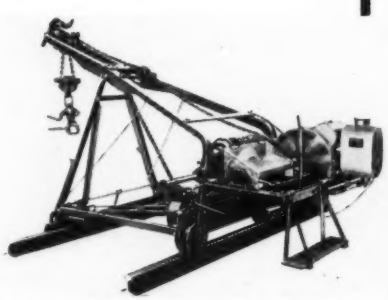

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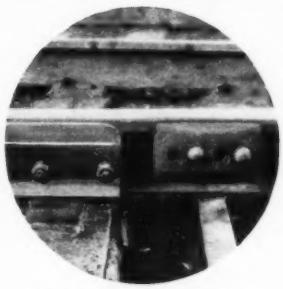

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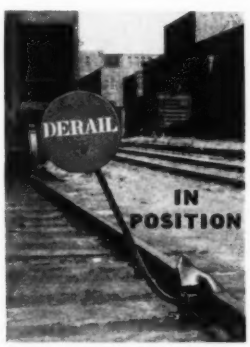

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Railway Engineering and Maintenance

War

Its Effects on Railway Maintenance

WE are again standing at the threshold of a crisis in world affairs. Within the last month three of Europe's greatest nations, and a smaller one, have engaged in a conflict that is already affecting conditions through the world—and no one can yet foresee the full ultimate effects.

There are those who contend that we in America can and should remain out; there are others who contend with equal vigor that, do what we may, we cannot avoid being drawn into the conflict. Time alone will reveal who is correct. Regardless of the outcome, however, the railways of this country face new demands; no small part of the responsibility will fall on maintenance of way forces. They must prepare to meet these new and more exacting conditions promptly and efficiently. To this end every employee may well study the part that he can and should take.

Increased Traffic

Whether we enter the war or not, we are certain to be called on to move greatly increased quantities of grains, steel and other materials required by the people at war. This traffic may be expected to increase quickly. Already this movement is presaged by rapidly rising prices for grains, by increasing orders for steel and by the acceleration of movements of ore to the mills. If this rising traffic is to be moved quickly and efficiently, it is evident that railway tracks and structures must be brought into proper condition before the arrival of winter brings an end to normal maintenance activities.

When we attempt to forecast the possible effects of the European conflict on railway traffic in this country, we are aided by a review of our experiences in the World War of 21-25 years ago. Following the sudden and unexpected outbreak of hostilities in August, 1914, there was a decline in business activity that carried into 1915. As a result, there was a slight recession in traffic in 1915. In 1916, however, the demands of the warring nations for materials began to mount and our railways handled 19 per cent more business than in 1914. In 1917 and in 1918, with America in the war, our traffic rose to 38 per cent and 42 per cent above the level of 1914, and even then the railways fell far short of meeting the heavy demands which were made upon them.

So far as the present outlook for business on the railways of America is concerned, there is little reason to anticipate a decline in traffic comparable with that which occurred in the closing months of 1914 and the early part of 1915, for conditions now differ widely from those which prevailed 25 years ago. In the earlier war, the outbreak of hostilities occurred so suddenly that America, in common with the rest of the world, was so unprepared that it was thrown into a state of confusion and uncertainty for months. The present war, on the other hand, has been coming to a head for so long and its inevitability has been so obvious to all that American industry has had ample opportunity to prepare for the changed conditions precipitated by the war and is moving into faster production schedules with complete absence of uncertainty and confusion. Although the war is less than a month old, it is already resulting in increased traffic on the railways and there is no reason to anticipate that this increase will be interrupted.

Conditions Today

As concern over the war increases, railway officers are hastening to assure the public that the roads are able to handle any traffic that may normally be anticipated. So far as equipment is concerned, they can handle at least 25 per cent more traffic than they are now handling, with present facilities. By repairing 200,000 freight cars and 8,000 locomotives now awaiting repairs, they can increase their capacity 45 per cent. This is made possible by an increase of 61 per cent in the speed of freight trains and an increase of 106 per cent in the tons handled per train hour, as compared with 1920.

Yet, in spite of the great increase in the efficiency with which we are now using our railway facilities, we must face the fact that the railways were in far better shape physically in 1914 than they are now. Measured in carrying capacity, they now have 600,000 less freight cars, with 83,000,000 tons, or 6 per cent, less capacity, and less than 27 per cent of these cars are now less than 10 years old, as compared with 78 per cent in 1914.

Roadway Facilities Under-Maintained

In roadway facilities, the conditions are similar. Not only do we have 16,000 less miles of main lines now than in 1914, but our present tracks and structures are seriously under-maintained. In the nine years, 1921-29

inclusive, the railways spent an average of $815,172,000 for maintenance of way. In the nine years, 1930-38 inclusive, they spent an average of $448,818,572. In the last nine years there was an accumulated deficiency, therefore, of approximately $3,300,000,000.

Not all of this deficiency in expenditures is reflected in the condition of the property, for there are large offsetting factors of lessened traffic, etc.; it is equally patent, however, that the deficiency is very real and very sizeable—possibly approximating at least two full years of normal expenditures. Much of this has accumulated on secondary lines but it exists as well on the most important lines, as is evidenced by the marked increase during the last year or two in the number of rail failures due to transverse fissures—a form of fatigue failure.

This deficiency is especially severe in those multiple main and side tracks which have not been needed to handle the reduced traffic of the last 8 or 10 years and which have, therefore, been left unused and unmaintained, or used only for the storage of surplus or bad-order equipment. With a recovery in traffic, it will become necessary to restore these tracks to service and before this can be done, it will become necessary to retie and otherwise rehabilitate them. Similarly, it will be necessary to repair many freight houses and other buildings and, without doubt, replace not a few facilities that have been abandoned and removed.

New Difficulties

It will also be necessary to conduct these enlarged programs under more difficult conditions than have prevailed in the past. As factories increase their operations, it is to be expected that they will make inroads on railway forces, necessitating the recruiting and training of men inexperienced in railway work, even beyond the numbers necessitated by the increase in maintenance forces. Under conditions of active demands for labor, it is to be anticipated also that the turnover among maintenance forces will also be greater.

Equally serious will be delays in the receipt of materials which, although absent during the last 10 years of reduced operations, always accompany periods of increased industrial activities. It is to be anticipated that these delays will be more serious than usual with the onrush of orders, for the industries have long been under-manned and will themselves be forced to recruit many inexperienced men. Especially in those industries where experienced mechanics are required, it is to be expected that full production will be seriously delayed.

Such forecasts may seem visionary at a time when we are still confronted with widespread unemployment and surplus production in all directions; yet it has been the accompaniment of every war and there is little reason to expect that this experience will not be repeated. At any event, the forehanded maintenance officer will take such measures as are within his control to anticipate these possibilities in order that he may be prepared, if they develop, to cope with them successfully. That this is not an idle theory is evidenced by the fact that within the last two days prior to the writing of these comments, one railway has ordered 30,000 tons of rails and another railway has ordered 50,000 tons, in addition to releasing the rolling of 30,000 tons already on order. Such actions are a forerunner of the days that are ahead of us and that will bring problems of increasing severity for maintenance men.

Building Repairs—

Take Advantage of Modern Materials

AMONG the many important problems that confront maintenance of way men, unquestionably the most important at the present time have to do with the economical maintenance of their tracks to meet the increased demands that are being made on them by the prevailing increased speeds of operation. And with major war conditions in Europe, and the effect that this is bound to have upon agriculture and industry in this country in producing increased rail traffic, it is a certainty that these problems will be intensified.

However, if the railways are to function adequately, and with satisfaction to the public, there are other problems to which they must give attention at the same time, one of which is the proper maintenance of their buildings, and, more particularly, their passenger stations. Already, many outlying stations have gone beyond the point where they can be put in condition by what is ordinarily considered routine maintenance work, to a stage which requires what is more appropriately termed overhauling. A number of roads that are confronted with this problem have given it some attention, taking one station at a time, and in most cases where any considerable amount of work has been required, have taken the opportunity to modernize the structures as well, particularly the interiors. A good example of such a renovation project is described in this issue, this having to do with the passenger station of the Union Pacific at Manhattan, Kan., an old-fashioned brick structure, which was so altered and redecorated, and equipped with new heating, lighting and toilet facilities, that for all practical purposes it is now equivalent to a new station.

But with due regard for all of the work of this character which has been done in recent years, it represents only a small fraction of that which should and must be done in the near future if the railways are to continue to maintain stations anywhere near in harmony with the improved service which they are rendering in almost every other respect. In this work, it would be a mistake to undertake repairs and rearrangements without at the same time giving full consideration to modernization.

Never before have building men had at hand such a wide variety of materials and equipment to effect pleasing, if not striking, results, and in many cases it will be found that the newer materials and units of equipment can be made use of at smaller costs than the expense involved in making extensive patch repairs to old facilities. At the same time, considering wall and ceiling fac-

ing materials, for example, such as plywood and wallboards of various types, the more modern materials can be applied with speed and economy and with minimum interference with normal station operations. At the same time, they are highly utilitarian in character, lend themselves to pleasing treatment or decoration, and, not infrequently, add materially to the insulating value of the surfaces to which they are applied.

The entire building industry has made great strides in modernization during the last eight or ten years. All of these advances are available to railway building men in the solution of the problems that confront them in station and other building modernization work. It is most desirable that they keep fully informed of these advances and take full advantage of them.

Irregular Line

Its Effect on Riding Qualities

PROBABLY no element of track maintenance is of greater importance than line, for irregularities in line create corresponding defects in almost every other element of the track structure. If the line is allowed to become irregular, it is almost certain that the track will soon be out of level and that the gage will be irregular. For this reason, if the track is not kept in good line, there is little else that can be done to make it ride smoothly. Furthermore, if the line is not corrected, these defects become progressively worse and the riding qualities of the track degenerate in corresponding degree.

If the line is irregular, the rails are subjected to heavy blows and severe lateral pressures, as the wheels tend to resist displacement, the effect being to create still greater irregularities in the line. This action causes excessive wear on the rail, the spikes, the tie plates and the joint fastenings, all of which affect the gage. Thus, irregular line is almost invariably accompanied by loose rail, wide gage and kinked joints. If the track is neglected, these defects not only grow progressively worse with the passage of every train, but they extend themselves, since the lateral pressures tend to continue some distance beyond the irregularity itself.

Irregular line causes rolling and lurching movements in the cars, which develop into severe side swings as the speed increases. It is not necessary for the track to be grossly irregular to produce this effect, for only slight irregularities that are scarcely noticeable at low speeds may cause unpleasant sensations and discomfort as the speed increases, while under high-speed operation they may also cause considerable apprehension.

Old-time trackmen developed an uncanny expertness in lining the lighter rail sections with which they worked, producing a sharp, distinct line that was almost startling in its freedom from irregularities. With the advent of the heavier rail sections of today, with their wider heads and less clearly defined outlines, the lining of track has become far more difficult, and few foremen can produce as exact a line as was formerly possible. Yet, high-speed train operation demands complete freedom from irregularities, to insure maximum comfort to passengers.

Experience has demonstrated that, under comparable conditions, heavy rail does not get out of line as easily or as quickly as light rail but, conversely, it is more difficult to move back into line. For this reason, since many section gangs do not now include enough men to line track laid with heavy rail, not a few foremen have neglected their line until today conditions with respect to line are far from satisfactory. In view of this situation, of the increasing demands for refinements in line, created by shortened schedules, and of the inherent difficulty of obtaining a sharp line by reason of the broad tops of the rails now generally in service on important lines, it becomes apparent that the time has come when maintenance officers should give this subject more consideration than it has received from many of them.

One of the strong appeals of the faster service that is so popular today is the comfortable riding of the high-speed trains. No factor is likely to become so strong a deterrent to the continued popularity of these trains as discomfort growing into apprehension, which is likely to develop unless more than ordinary attention is given to the maintenance of good line. These facts indicate the desirability of some plan for assisting those foremen whose forces are too small to keep their track lined, and of training other foremen to do a better job of lining than some of them are now capable of doing.

Heaving Track

Committee Studys Underlying Causes

NO man is better qualified to talk about heaving than he who has had to maintain heaving track in good-riding condition and constantly safe for the passage of trains at normal speeds. It might be pertinent to say to those who have never been through such an experience that at best it is no sinecure and under unfavorable conditions it may be worse than a nightmare, with this difference that the nightmare is soon dissipated, while the anxiety induced by shimming requirements may extend over several months. Then, when the frost begins to go out of the roadbed, one must start all over, reversing the previous operation of placing the shims, by removal or by the temporary substitution of thinner shims. At this time the tempo of the work is accelerated and anxiety is increased because the frost retreats unequally and the track usually settles out of level. In many cases the forces that were able to keep abreast of the shimming are insufficient to handle their removal and slow orders become necessary in the interests of safety.

Although many men are familiar with heaving track and with the requirements for placing and removing shims, and know that water is at the seat of the trouble, only a relatively few of them have had an opportunity to make exhaustive studies of the underlying causes and of the methods that are best adapted to eliminate the trouble. The literature on this subject is extremely meager and most of what has been written on the subject is not available to supervisory officers. For these reasons, the Roadmasters' Association is to be commended for having assigned this subject for study and the committee is to be congratulated for having prepared the excellent report on heaving track which appears on a later page in this issue.

Removal of an Old Tower and the Construction of a New Facade of Modern Design, Greatly Improved the Appearance of the Exterior

Modest Expenditure Modernizes Old Station

Removal of an old tower entrance, rearrangement and redecoration of the interior and addition of modern heating, lighting and toilet facilities, transformed an old-fashioned brick depot at Manhattan, Kan., with moderate expenditure into the equivalent of a new modern station

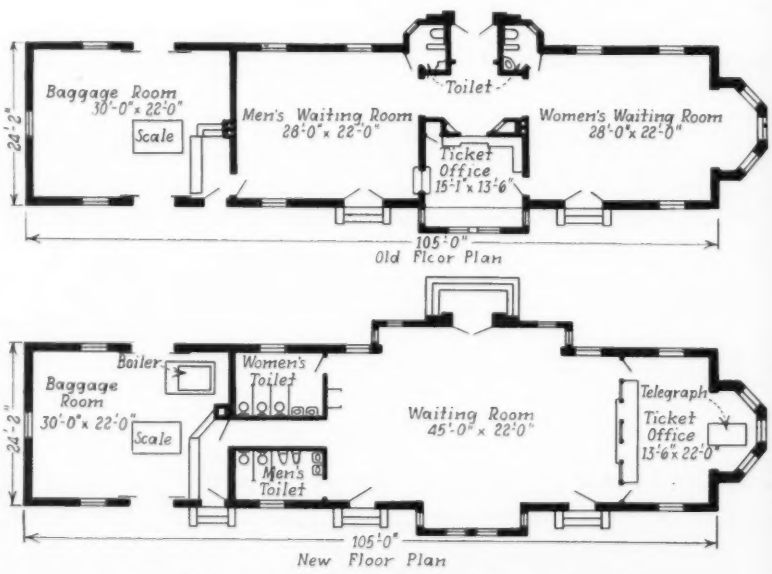
MANHATTAN, Kan., a college town of approximately 10,000 population, on the main line of the Union Pacific between Kansas City, Mo., and Denver, Colo., and a junction point for a branch line extending northerly to Lincoln, Neb., is the source of considerable passenger revenue from both townspeople and college students. Recently in order to serve this up-to-date town properly, the Union Pacific decided to modernize its passenger station at this point.

Before Modernization

The station, which was structurally sound, is a one-story brick building with cut stone trim and a clay tile roof, approximately 24 ft. wide and 105 ft. long, located on the north side of the track and parallel to it. At the east end, a bay or alcove 12 ft. 6 in. wide extends out 7 ft. 6 in. The outstanding old-fashioned feature of the exterior of this station was an ornate cupola-type tower of the Victorian era, facing the street side. The interior arrangements were also out-of-date, with separate waiting rooms for men and women, separated by a ticket and telegraph office on the track side of the depot and a lobby on the street side. The women's waiting room was at the east end and the baggage room was at the extreme west end, adjacent to the men's waiting room. The interior of the old depot was finished with walls of yellow pine wainscoting five feet high and stained a dark brown, with plaster finish above and a high vaulted ceiling. The wood floor was in good condition but was somewhat worn and had been discolored by oil and dirt. The building was heated with old-fashioned cast iron depot stoves and the lighting fixtures were out-of-date.

Rearrangement of Rooms

The plans for modernization called for a rearrangement of the rooms to provide one large main waiting room



Floor Plans of the Station Before and After Modernization

in the center of the depot with ticket and telegraph office at the east end. This required the removal of the old ticket office partitions and the construction of one new partition between the new ticket office and the waiting room. The old toilet room partitions and facilities were also removed from their former locations facing the lobby on each side of the street entrance and new partitions were built at the west end of the waiting room, with a passageway between leading to the baggage room, which remained the same size as formerly. The new ticket office was 13 ft. 6 in. wide and extended the full width of the depot, the large bay window at the east end of the depot adding considerable space to this room. This rearrangement provided larger toilet rooms than formerly existed and a large central waiting room approximately 22 ft. wide and 45 ft. long, with additional space provided by recesses on both sides.

The West End of the New Waiting Room. The Outstanding Effect of Modernization Was the Creation of an Unusually Bright and Attractive Atmosphere

Interior Renovation

A main feature of the modernization was the interior redecoration to produce a modern appearance and an attractive, cheerful atmosphere. The walls, ceilings and floors were completely altered. The old, dark-colored wainscoting was removed and the walls were replastered and painted in one color, a light tan shade. Black and tan colored, heavy inlay linoleum was laid over the old flooring with a black composition sanitary base, producing an attractive floor, easy under foot and easily cleaned. A new ceiling was built of light colored, light-weight celotex tile, except over the ticket and telegraph office, where the ceiling was constructed of San acoustic tile to eliminate noise. New interior millwork, chair rail and door and window trim, painted an ocher shade, completed the modernization of the walls. A large, massive double oak settee in the center of the waiting room and three single settees, one in the recess on the south side and two along the north wall, completely refinished, were installed to provide adequate seating facilities for the waiting passengers. Other furnishings in the waiting room consisted of a parcel locker and telephone booth against the west wall to the right of the hallway leading to the baggage room and a new sanitary type drinking fountain at the left of the hallway.

The main waiting room and the telegraph and ticket office were separated by a new 8 ft. frame partition, with two ornamental wrought iron ticket window grilles separated by frosted glass panels. Two doors to the office were provided, one at each end of this partition. The door on the track side was a Dutch door while the one on the street side is of standard type with glass sash in the upper portion. In the new ticket and telegraph office, the telegraph desk was located in the east bay window and outside window service for trainmen was also provided.

An Interior View of the Modernized Passenger Station at Manhattan, Kan., Showing the New Ticket Office Partition and the East End of the New Waiting Room

Other Facilities Modernized

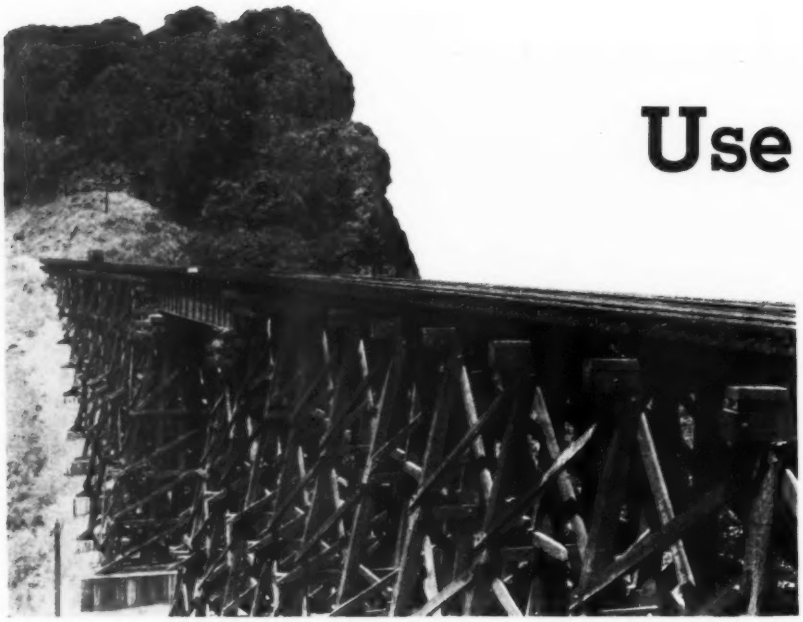
One of the most important interior changes, from the standpoint of improving appearances, was the installation of a new steam heating system, with tubular radiators placed along the walls in all the rooms, which permitted the removal of the old unsightly cast iron depot stoves. The new furnace and boiler were placed in the northeast corner of the baggage room, supported on 12-in. brick foundation walls. A new chimney was built and the old chimneys were removed.

New Electric wiring and lighting fixtures of Ivanhoe Silvo glass, which produce a natural daylight effect were installed. The new fixtures, attractive in shape, lend an additional modernistic touch to the appearance of the interior. The new toilet rooms, with floors of chemically-treated cement, were equipped with new and modern plumbing fixtures and metal toilet partitions.

Exterior Changes

The principal exterior improvement was the removal of the old tower and the construction of a facade of more modern design over the street en-

(Continued on page 590)



Use of Timber

Gains on

In the Construction of this Timber Trestle Spike Grid Connectors Were Used at All the Brace Connections

DURING the last five years long-established methods of fabricating timber structures have undergone extensive revision, largely because of the introduction and widespread application of timber connectors. This trend has been particularly noticeable on the railroads which, being among the five largest users of forest products in the country and, therefore, anxious to adopt measures that will promote economy in the use of such products, have been quick to see the possibilities inherent in the use of the connector system. As a result connectors are today being used in a variety of railroad structures, including trestles and overhead highway bridges, various types of buildings, timber piers, loading platforms and related structures. Typical examples of such construction are described later in this article.

Historical

It is interesting to review the circumstances surrounding the development of the connectors and their introduction into this country. Prior to the World War connectors were not in general use anywhere, but as the task of rehabilitation got under way following the war the need for low-cost construction became imperative, particularly in central Europe, and European engineers were led to seek means of improving the efficiency of timber construction. The timber joint, long recognized as the central link in all timber construction, was the logical point for improvement and, under the pressure of economic necessity, the various types of modern timber connectors were developed.

The merits of the connectors achieved immediate recognition and the use of the various types spread rapidly in Europe. They were first introduced into the United States in 1933 by the National Committee on Wood Utilization of the United States Department of Commerce in co-operation with the United States Forest Products Laboratory, Madison, Wis., where many tests were made to determine working loads on connector joints. Next, the Timber Engineering Company, Washington, D. C., was organized as a subsidiary of the National Lumber Manufacturers Association for the purpose of making the connectors available in this country. Through this company patent rights were secured on several of the more important types, which were immediately placed on the market.

Connectors have thus become an engineering asset through the efforts of the lumber industry. In addition, data for improving the design of timber structures, including information regarding the most efficient systems of fabrication, have been made available to interested parties. That timber connectors have been received with favor in this country is indicated by the fact that during the last five years they have been used in the construction of more than 12,000 structures embodying nearly 500,000,000 ft. b.m. of lumber.

Modern timber connectors consist in general of metal rings, plates or grids which, when embedded partly in the faces of overlapping members, transmit loads from one structural member to another. Certain types, such as the split ring and the flanged shear plate, fit into precut grooves or daps while other types, such as the toothed ring and the spike grid, are embedded in the timbers by means of pressure. This pressure may be developed either by presses or by drawing up the nut on a high-strength rod which is later replaced with a common bolt.

Increases Joint Strength

The action of the connector in the joint is to increase the shear area which actually carries the load. In timber joints it is in the section of the timber nearest the contacting faces that the greatest shearing stresses are developed, and by embedding the connectors in this highly-stressed shear area the efficiency of the joint is augmented materially. In other words the increased bearing area of the connector over that of the bolt increases the load capacity of the joint. For example, a 4-in. split ring with a ¾-in. bolt will carry three times the load of a ¾-in. bolt alone.

The two types of connectors principally used in railroad work are the spike grid and the flanged clamping plate, although those of the split-ring and toothed-ring types are also widely used. Spike grids find their greatest application in docks and in fastening the bracing for pile bents in timber trestles. The equipment recommended for embedding these grids consists of a ¾-in. diameter high-strength rod, a ball-bearing washer, two flat washers, and a re-

Connectors Wide Front

Showing One of the Plywood Gusset Plates, With Split-Ring Connectors in Place, in a Temporary Vertical Lift Bridge

Since they were first introduced into this country about five years ago, the various types of modern timber connectors have achieved wide application among the railroads and other large users of timber. In this article Mr. De Vries reviews the development of timber connectors, tells how their use increases the efficiency of timber joints and describes typical examples of their application in various specific railroad structures

By VAN BEUREN W. De VRIES

Assistant Director of Information,
National Lumber Manufacturers Association, Washington, D. C.

versible ratchet wrench with a 24-in. handle. The timber joint is first assembled, using the rod for embedding the connectors. After the connectors are completely embedded, the rod is removed and replaced with a common machine bolt. Where conditions permit, hydraulic jacks may also be used to advantage for embedding grids in timber members.

The flanged clamping plate mentioned above has been developed in cooperation with the Chicago, Rock Island & Pacific for use as a tie spacer on timber trestles. This plate has teeth on one side only and two flanged ends which fit over the sides of the ties, the teeth pointing upward and penetrating the guard timber. These plates are installed on the Rock Island by placing them loosely under the guard timber at each point where a plate is to be used, and an awl is then used to scratch the location of each plate on the guard rail after which the latter is turned over and the plates are driven in with a mall. The guard rail is then ready for installation and is simply dropped in place over the ties. The fact that the clamping plate fits over the edges of the ties rather than being embedded in them precludes any possibility that the treated portion of the ties will be penetrated to permit the entrance of moisture. When these clamping plates are used it is necessary to place bolts in only about every fourth tie. Typical examples of the use of other types of timber connectors in railroad construction are described in the following paragraphs.

Enginehouse Roof Trusses

The use of timber connectors in the fabrication of roof trusses for enginehouses is illustrated by a structure on the Chesapeake & Ohio at Clifton Forge, Va. This enginehouse embodies nine roof trusses, eight of which are 24 ft. 5 in. long, while the other, which spans two stalls, is 48 ft. 10 in. in length. The members in these trusses are held together at the panel points by from one to six ¾-in. bolts but the required bearing areas for transferring the stresses were obtained largely through the introduction of split-ring connectors between the members, these connectors being, of course, concentric with the bolts. These trusses also incorporate connectors of the toothed-ring type which were used in the bolted connections between the truss-supporting blocks and the columns. The trusses were entirely preframed and after treatment the eight short trusses were reassembled for shipment while the long trusses were shipped in pieces.

Another extensive installation of timber connectors is embodied in an automobile-loading dock constructed by the Detroit Terminal railroad. This dock, which is 600 ft. long and 50 ft. wide, employs 35 timber trusses. In the fabrication of these trusses, 2½-in. split-ring connectors were installed at all joints. Incidentally, the methods that were followed in fabricating and erecting this structure are worthy of mention. To expedite the construction work all material, including the girder beams, main trusses, jack trusses and columns, was fabricated,—that is, cut to size, bored and grooved at the site with the use of portable equipment. The main trusses, including the columns and jack trusses, were assembled in complete units and stacked at the building site with the aid of a crawler-mounted crane. As progress in the construction of the sub-structure permitted the same crane was used to set the trusses into their final position in the structure.

Sun Valley Lodge

Sun Valley Lodge, a winter resort hotel built by the Union Pacific in Sun Valley, Idaho, is an example of the larger types of structures built with timber connectors. The lodge is of modern construction and has accommodations for 250 guests. The roof framing is of timber construction and is designed to carry a total load of 65 lb. per sq. ft. It employs 2-in. by 12-in. rafters braced with 2-in. by 6-in. struts and collar beams. For the connections between these members toothed-ring connectors were used. Thus, although the loading conditions were severe for a roof system of the trussed rafter type the use of connectors made possible this relatively light type of roof construc-

tion. Toothed-ring connectors were also used in fastening the tie pieces of the A-frames and in fabricating the octagonal monitors that extend above the roof.

Another illustration is provided by two warehouses constructed by the Northern Pacific at Butte, Mont. Each of these structures is 60 ft. by 100 ft. in area and uses 34 Howe trusses having a span of 60 ft., a rise of 15 ft. at the mid point and a spacing of 3 ft. Timber connectors of the toothed-ring type are used in all connections in these trusses.

Several years ago the Chesapeake & Ohio undertook an extensive repair program on some of the piers at its large tide-water terminal at Newport News, Va. Among the structures involved in this program was Pier No. 2 which is 576 ft. long and 60 ft. wide. This pier has two sets of tracks along each edge and a longitudinal plank walkway at the center. It contains 48 bents spaced 12 ft. apart and each bent has 15 load-bearing piles, two batter piles and two fender piles. Each bent has seven diagonal sway braces on each side and the bolted connections between each of the sway braces, the pile cap and the piles requires four spike grid connectors. These grids enable the joints to develop practically the full working stress of the timbers. The overlapping joints in the post caps, each consisting of two 8-in. by 10-in. timbers bolted together, are secured by means of ¾-in. bolts and 4-in. split ring connectors.

In a Highway Bridge

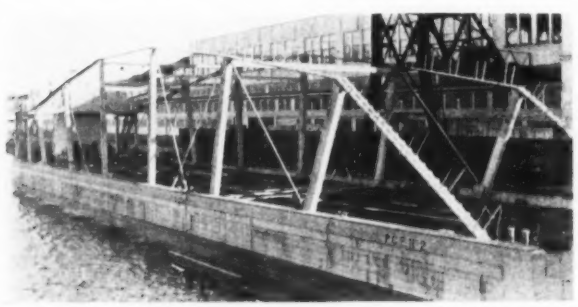
An example of the use of connectors in highway-railway grade separation structures is found in an overhead bridge carrying a North Dakota highway over the main line of the Chicago, Milwaukee, St. Paul & Pacific a short distance across the state line from Lemmon, S. D. With the exception of the hand railings and of the low concrete piers or sills which support two of the bents, this bridge was built entirely of creosoted timber in accordance with standard plans of the North Dakota State Highway department. The main span of this structure is 37 ft. long and is flanked on each side by an intermediate span 25 ft. in length and an end span 19 ft. 9 in. long.

The floor construction of this bridge consists of a laminated wearing surface laid on 10 lines of stringers. An interesting detail of construction is the curbing or wheel guard. This is of two-ply construction with an 8-in. by 12-in. timber on top and a 6-in. by 12-in. timber on the bottom. The upper timber is continuous but the lower one is made of short pieces to permit the introduction of drain openings 12-in. wide at regular intervals. These curb members are secured in place by bolts that extend through the laminated floor and the exterior stringers, with toothed-ring connectors being interposed between the upper and lower curb members and between the latter and the floor.

Construction View of the Automobile-Loading Dock of the Detroit Terminal, Which Incorporates Split-Ring Connectors in the Timber Trusses

Connectors in Falsework

Timber connectors have been successfully used in the fabrication of timber falsework for concrete bridges. An example of this application is provided by a viaduct near Fosters, Ohio, which carries a highway over the Little Miami river and two high-speed tracks of the Pennsylvania. This structure uses concrete arch spans ranging in length from 155 to 175 ft. Three-hinged timber arches embodying split-ring connectors at the joints were used as the centering for the arch spans, erection of which caused no interference with railroad traffic.



The Construction of this Car Ferry Barge of the Pacific Great Eastern Involved the Use of Many Timber Connectors in the Interior Bracing System

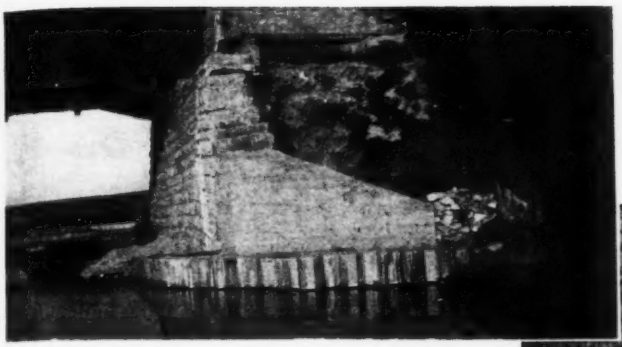
The manner in which timber connectors can be employed to advantage in the construction of car ferries is illustrated by a 14-car barge of timber construction that has been built by the Pacific Great Eastern. This barge, which carries three standard-gage railroad tracks on its deck, has an over-all length of 210 ft. and a displacement of approximately 900 tons. The hull of the barge is somewhat similar in appearance to that of a scow and the construction is of a particularly heavy type. In the interior of the vessel and extending fore and aft are three solid bulkheads or diaphragms of heavy timbers, each of which is arranged under, and provides the support for, one of the tracks on the deck. At 10-ft. intervals transversely throughout the length of the barge, these bulkheads are connected with the side framing by means of timber bracing trusses which are stiffened and strengthened through the use of timber connectors at the joints.

An Unusual Structure

An example of an unusual structural type made possible by the use of connectors is found in a temporary bridge constructed across the Sacramento river at Sacramento, Cal., to carry the tracks of the Sacramento Northern railway during the construction of a permanent bridge. The California State Highway Commission, which built the temporary span, found it necessary to design a movable structure which would be sufficiently low to permit the old draw span, while still in use, to be swung over it. This required that the base of rail on the temporary span must not be more than 20 in. above the high-water level. Under these circumstances, giving due weight to the factors of speed and economy in construction, a vertical lift span of timber construction was chosen as the best type of temporary bridge for the purpose.

As this structure was to have a length of 90 ft., the use of a pony truss appeared to be most desirable from a purely structural standpoint and a Howe-type truss of timber construction with steel hangers was adopted. The necessity of locating the base rail only 20 in. above the

(Continued on page 590)



Left—Steel Sheet Piles Formed Cells About the Abutment for Grouting. Below—Showing a Section of Wing Wall Replaced and the Cracks in the Old Masonry, Which Were Filled with Cement Mortar.

Underpinning

Saves Old Masonry Abutment

By O. F. DALSTROM

**Engineer of Bridges,
Chicago & North Western,
Chicago**

In this article the author describes how the Chicago and North Western stabilized an old flood-damaged bridge abutment by pressure-grouting gravel ballast deposited about the structure's footing. A facing of steel sheet piling about the abutment held the stone fill in place and insured the confinement of the grout to the areas desired

PROMPT action to stop erosion and the application of an unusual method of making permanent repairs featured the saving and restoration to service of a 60-year old stone-masonry abutment on the main line of the Wisconsin division of the Chicago & North Western after it had been damaged severely by flood waters during June, 1938. This restoration was accomplished after the abutment had been undermined to the extent that it had settled and tipped forward about 2½ in. and one of the wing walls had partly broken off and fallen away.

This structure, of which the abutment in question forms a part, provides a waterway 48 ft. wide between faces of abutments for the north branch of the Kishwaukee river, near Harvard, Ill. This stream, although normally small, drains a relatively wide valley through which it meanders, and passes under the bridge at an angle quite different from that formed by the axis of the valley. The opening had previously been of ample width to carry all flood waters for a period of almost 60 years without increasing the velocity to the point of scour. In 1938, however, rains occurred in this territory with unusual frequency and with even distribution with respect to time. As a result, there were no dry periods to permit complete run off or to give subsurface seepage a chance to dry the ground. For this reason, the ground was saturated in all low places throughout the season, with consequent heavy runoff and softening of both the surface and the underlying soil. This opening has passed safely the runoff of many heavier rains than the one that created the damage in June, 1938.

Meandering Channel

The meandering channel of the north branch of the Kishwaukee river swings under Bridge 82, the structure in question, almost at right angles with the axis of the valley, which intersects the east abutment at an angle of about 45-deg. The normal channel is small, and the fall slight, so that even at moderate flood stages the water spreads out over the valley and approaches the bridge opening at approximately the same angle as the axis of the valley.

In the flood that disturbed the abutment, the direction of the current was such that the swiftest part hit the east abutment at about its center, and as it was deflected away it exerted a churning and digging action at the downstream end of the abutment footing and under the downstream wing wall. This digging extended to a depth of about 5 to 6 ft. below the footing, the excavated material being carried away in suspension by the swift current as it was deflected from the face of the abutment.

The high water prevailed for only a few hours, but the erosion was sufficient to cause the end of the wing wall to break off and fall away. The abutment also settled so that it came forward about 2½ in., as measured by the travel of the girder sole plate on the pedestal that is anchored to the bridge seat. The forward movement of the abutment was stopped when the backwall brought up against the ends of the plate girders.

Prompt measures were taken to stop the erosion and to restore the support under the abutment, by dumping gravel ballast into the hole in front

of the abutment and wing until it lay against the face of the abutment halfway up to the bridge seat. After the flood receded, stabilization of the abutment was accomplished in general in accordance with the accompanying illustrations. Steel sheet piles were driven on a line nearly parallel with and about 4 ft. from the face of the abutment and wing. The space between this row of sheet piles and the abutment was divided about every 10 ft. by a cross wall of sheet piling from the abutment to the intersection with the main row of piles. The gravel above the top of these sheet piles was shoveled off into the water hole, the portion of the wing that fell off was replaced with concrete, and the cracks that opened up in another portion of the wing were filled with mortar. Then the final, and perhaps the most important operation was carried out, consisting in an attempt to solidify the gravel in the cells formed by the sheet piling by injecting cement grout into it.

Accordingly, the contractor brought to the site an air compressor and equipment for delivering grout through a pipe line under air pressure. Delivery of grout was effected through a 2-in. pointed pipe driven into the gravel. During driving the point end of the injection pipe was closed with a loosely fitting flanged plug that could be driven out with a smaller pipe inside the larger one. This plug was used to keep the pipe clear and to produce an open end of the grouting pipe after driving.

A number of difficulties were encountered but, while it has not been practicable to determine how complete the grout injections were, evidence of the penetration of grout in some of the cellular spaces is afforded by the fact that 31 sacks of cement were injected into one of these spaces. Assuming a 35 per cent void space, it appears that that section is grouted into a solid mass. This amount was much smaller for other cells, but a part of the difference was accounted for by the difference in depth of the gravel. In some cases, it was difficult to get any appreciable quantity of cement into the gravel, even with a pressure of 100 lb. per sq. in. and in some instances, the application of a pressure of 100 lb. disturbed the gravel, but resulted in little movement of grout from the air-grout chamber.

Several conclusions of interest to engineers can be drawn from the conditions that permitted the damage to occur: (1) Effective protection against erosion should be provided at the point where the current leaves the obstruction, as well as at the point where it impinges; (2) the axis of a stream during flood stages may not be the same as the axis of the normal-flow channel; (3) it is the flood-time axis that is important.

Other conclusions of interest to maintenance officers which can be drawn from the experience gained in making the permanent repairs are that (4) the equipment for grouting a mixture of sand and gravel should be of such design that the pressure can be controlled at all times, and that the rate of delivery of the grout under the controlled pressure will be such that it will be given time to permeate to a considerable distance in every direction from the discharge end of the delivery pipe; and (5) a technic developed from experience in this type of grouting and a knowledge of the material to be grouted is necessary for best results. A correct interpretation of what happens or does not happen can be expected only from men experienced in such work.

Both temporary and permanent repairs were carried out under the immediate supervision of the writer and C. H. Perry, division engineer. The contractor was the Jutton-Kelly Company, Milwaukee, Wis.

Union Pacific Modernizes Old Station

(Continued from page 585)

trance in the same brick and cut stone trim as the remainder of the depot. In addition, the solid double doors at this entrance, with elaborate panelling above, were replaced with double doors of modern design, with glass in the upper half and a fixed glass transom above, harmonizing with the simpler lines of the new entrance. On the track side, both of the old-fashioned solid double doors leading from the waiting room to the platform were replaced with modern single doors, with glass in the uppor portion and glass transoms above. These improvements helped modernize the exterior appearance and also increased the attractiveness of the waiting room by admitting more light. New steps, similar to those at the waiting room doors on the platform side of the station, were built at the baggage room door. In addition, removal of the old chimneys and the construction of a new chimney not quite as tall and with less elaborate lines, also improved the outside appearance. The exterior improvements were completed by painting all the wood and metal work in suitable colors which blend with the brick work.

This work, which was accomplished at a cost of approximately $15,000, transformed an old depot into a station of exceptional attractiveness, which for all practical purposes is as good as a new one. While the outstanding effect of the improvements was the creation of a large main waiting room with an unusually bright and attractive atmosphere, all of these improvements, both within and without, combined to harmonize and alter the entire appearance of the station and make it modern in appearance and convenience throughout.

The designs for modernization of the Manhattan depot were prepared under the supervision of B. H. Prater, chief engineer, in the office of G. H. Trout, building engineer of the Union Pacific at Omaha, Neb., and the construction work was performed by the bridge and building forces under the direct supervision of N. C. Pearson, division engineer at Kansas City, Mo.

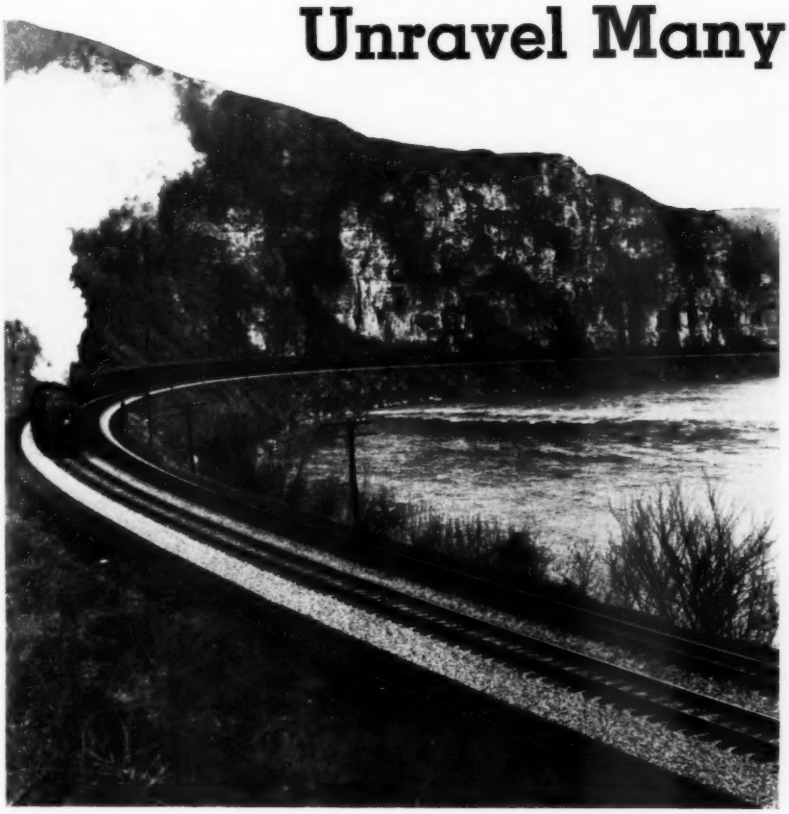
The Scenic Limited of the Denver & Rio Grande Western Double-Heading Up the Three Per Cent Grade Through Tennessee Pass at Mitchell, Colo.

Timber Connectors Gain Wide Acceptance

(Continued from page 588)

high-water level required that the floor beams be placed below the lower chords so that the latter would be sufficiently high to present the minimum of obstruction if it should be necessary to lower the span during the passage of a flood crest. In this structure connectors of the split-ring type were used in the chord splices and in the connections between the floor beams and the lower chords. Connectors were also employed in making certain connections in the towers which were likewise of timber construction. Here the connections between the gusset plates, which were of 29-ply veneer panelwood, and adjacent members were made with the aid of 2½-in. split-ring connectors.

Roadmasters Unravel Many Problems at Convention



Well-Maintained Track on the Norfolk & Western in West Virginia

The fifty-fourth annual convention of the Roadmasters and Maintenance of Way Association, with a large attendance and a program including six reports and three addresses by railway officers on current railway problems, and supplemented by an effective exhibit of materials and equipment presented by the Track Supply Association, was one of the most constructive in the many years of the association's activities

IMBUED with a high sense of seriousness and responsibility in the face of the many tasks which lay ahead of them, which augur to be more difficult and exacting than even those of recent years, members of the Roadmasters' and Maintenance of Way Association held their fifty-fourth annual meeting in the Hotel Stevens, Chicago, on September 19-21, and gave more than usual attention to a wide range of problems which confront them and which promise to become increasingly troublesome with further demands for increased speed of operation and the large increases in traffic which appear immediately ahead. The meeting, which was supplemented by an exhibition of maintenance of way materials and equipment presented by the Track Supply Association, was attended by approximately 300 railway officers, with a total attendance, including exhibitors, of more than 600.

The program, which was adapted especially to meet present-day problems of the roadmasters and other maintenance of way officers, included reports by committees on Anchoring Track to Meet Present-Day Conditions; Heaving Track, Its Causes, Control and Maintenance; The Maintenance of Curves for High-Speed Trains; The Qualifications and Duties of Roadmasters; The Utilization of Roadway Machines; and Specialized Versus Section Gangs. In addition the convention was addressed by C. E. Johnston, chairman, Western Association of Railway Executives, who welcomed the roadmasters to Chicago in the interest of still higher standards of roadway and track maintenance; by R. H. Smith, vice-president and general manager of the Norfolk & Western, who discussed the responsibilities of roadmasters and other maintenance of way men in matters of safety; by W. H. Hillis, engineer maintenance of way, Chicago, Rock Island & Pacific, on High-Speed Trains and Track Maintenance; and by C. B. Bronson, inspecting engineer, New York Central System, on Recent Trends in Rail Manufacture and Maintenance and Their Effects on Track Work. All of the committee reports, with abstracts of the discussions which followed their presentation, as well as the addresses by Messrs. Johnston and Smith, are presented in this issue. The addresses by Messrs. Hillis and Bronson will appear in subsequent issues.

Special features of the convention included an evening of motion pictures on Tuesday, at which were presented the locomotive slip test films taken by the Chicago, Burlington & Quincy, showing the effect on track of locomotives operated at high speeds, which were supplemented by comments by H. R. Clarke, engineer maintenance of way of that road; a Question Box session on Wednesday, at which many practical questions relative to modern track maintenance were submitted and discussed; and a banquet on Wednesday night, tendered to members of the association and their families by the Track Supply Association, which was attended by 481 persons. Another special feature of the program was a visit to the plant of the Inland Steel Company at Indiana Harbor, Ind., on Thursday afternoon, where members were given an opportunity to observe the manufacture of a variety of track

fastenings, including bolts, spikes, joint bars and tie plates. One hundred and fifteen members made the trip as guests of the steel company.

New Officers Elected

At the closing session of the convention, G. L. Sitton, chief engineer maintenance of way and structures, Southern, at Charlotte, N. C., was advanced from vice-president to president; J. J. Clutz, acting assistant division engineer, Pennsylvania, Trenton, N. J., and a director of the association, was elected first vice-president; A. B. Hillman, roadmaster, Belt Railway of Chicago, Chicago, and a director of the association, was elected second vice-president; and C. A. Lichty, Chicago, and E. E. Crowley, roadmaster, Delaware & Hudson, Albany, N. Y., were re-elected, respectively, secretary and treasurer. Three new directors were elected—E. J. Brown, district engineer maintenance of way, Chicago, Burlington & Quincy, Galesburg, Ill.; H. E. Kirby, assistant engineer, Chesapeake & Ohio, Richmond, Va.; and J. M. Miller, division engineer, Western Maryland, Cumberland, Md., Mr. Miller being elected to fill the vacancy created by the advancement of Mr. Hillman.

The secretary's report showed more than 500 members of the association in good standing, with 116 new members taken in during the year. Chicago was selected as the headquarters for the next convention, and the following subjects were selected for study by committees during the ensuing year: Ditching and Bank Widening—Methods and Equipment Best Suited for This Work; Handling Snow and Ice at Terminals and on the Line—Organization, Equipment and Methods; Effect of Weight of Rail on Track Maintenance; Welding—Its Uses in Track Work; The Maintenance of Gage—Its Importance Under Today's Higher Speeds—Causes and Effects of Irregular Gage and Means of Correcting It; and Slow Orders, Their Use in the Light of Present-Day Operating Conditions.

C. E. Johnston Opens Convention

Speaking for the presidents of the western railroads, C. E. Johnston, chairman of the Western Association of Railway Executives, welcomed the roadmasters to Chicago, commending them for their outstanding achievements during the last few years in the face of adversity and admonishing them to get the most out of their convention to fortify themselves for the strenuous days which he saw immediately ahead.

"This is a very important meeting of important representatives of an important railroad department," he said. "The railroad industry should be benefited greatly by this gathering, and you men, as individuals, should gain a great deal through your contacts here and through the discussions of the many complex and serious problems confronting us in maintenance of way work.

"In my judgment, there is no class of men in railroad service that deserves more credit for good work performed during the last few years, and in the face of adversity, than you maintenance of way men. I am sorry that it is not possible for me to say that the most strenuous period has passed and that from now on less pressure will be put upon you. That would certainly be good news for all, but I am afraid that conditions quite to the contrary will prevail. I believe we are all well on our way towards difficulties, the like of which we have not fully experienced to the present time. By that I do not mean to infer that you have not had plenty of difficulties in the past. Nor do I intimate that you are not prepared to meet any emergency in the future—because I know that you are."

F. B. La Fleur
President

Mr. La Fleur was appointed roadmaster on the Louisiana lines of the Southern Pacific, with headquarters at Lafayette, La., in 1919, and has held this position, with the same headquarters, for more than 20 years. He became a member of the Association in 1925, and ever since that time has been active in its affairs, both through committee membership and as a member of the Executive committee.

With regard to the problems confronting the railways, Mr. Johnston spoke of the many changes taking place in railroad operation and maintenance as the result of the competition of other forms of transportation, and of the heavy taxes with which the railways are burdened as compared with their competitors, and said, "The executives of your roads are leaning heavily upon you to assist them in meeting these problems."

Turning to the matter of safety, he said that "both you and I know how paramount safety is in railroad operation. Regardless of what takes place on the highways, the railroads can never afford to relent for a moment in their drive for safety on the rails. Over a long period of years the words 'railroads' and 'safety' have been synonymous in the eyes of the public and they should never be otherwise."

Greetings

E. M. Hastings, chief engineer of the Richmond, Fredericksburg & Potomac, and president of the American Railway Engineering Association, brought greetings from that association and commended the roadmasters upon the work of their association through the more than 50 years of its existence which, he said, had "constantly forged new links in the chain of progress which has been made by the railroads."

"It is particularly interesting," he commented, "to read the fine contributions that you have been making in these days of intensive maintenance work to meet the ever-increasing problems placed upon maintenance of way men because of higher speeds and more exacting service. The field is yet very challenging; we have not accomplished anywhere near the work that can be done; there are many problems yet to be solved and in the solving of these problems, hard work and careful thought are necessary on the part of each member of your association.

"I feel certain," he continued, "that with a fine history that is behind your organization, you feel challenged and impelled to look to the accomplishment of better things in the days ahead. If we who are concerned in the maintenance of the American railways live up to what is expected of us, we need to give the very best that we have, and to work with untiring effort towards the betterment of our maintenance practices and the improvement of our service to our railways."

Greetings from the American Rail-

way Bridge and Building Association were extended to the convention by Armstrong Chinn, its president, and chief engineer of the Alton, who said in part, as follows:

"Our associations, organized and working along similar lines, are doing a splendid work in advancing the science of practical railroad maintenance. During the last decade, which has probably been the most strenuous and difficult period in the history of American railroading, the members of our associations have, with less money than ever before, produced and maintained tracks and structures on which traffic has moved safely and comfortably at the highest scheduled speeds in railroad history. This is an accomplishment of which we can well be proud. It has been made possible by careful planning and supervision and the constant study of current problems such as your committees have been studying during the last year and on which they will report to you at this meeting.

"While there are many forms of transportation," he said, "none have yet equalled the railroads in low cost, freedom of movement or dependability. You have a great responsibility to your companies, to your nation and to its people to continue to provide and maintain the roadway and tracks required for this cheap and essential form of transportation. Knowing you as I do, I know you will not fail."

Speaking in behalf of the Track Supply Association, Lem Adams, its president, and vice-president of the Oxweld Railroad Service Company, extended an invitation to the members of the Roadmasters Association to study the 25th annual exhibit of maintenance of way equipment and materials held in conjunction with the convention. This exhibit, he pointed out, was presented for their benefit, "the representatives of the supply companies exhibiting being there to be of assistance in the effective use of their products in the solution of your problems."

Recalling his years of railway experience, ending with the position of chief engineer of the Union Pacific Railroad in 1933, Mr. Adams spoke of his long interest in the Roadmasters Association; of his having urged his men to attend its conventions and to study the railway supply companies' exhibits; and of an instance in which the recommendation of one of his roadmasters, based upon his study of a new, small track jack displayed at an exhibit of the supply association, led to the purchase of more than 1,000 of these devices in one year to equip every section gang on the road.

President's Address

In his annual address, President F. B. La Fleur reviewed the accomplishments of the association during the year, urged active participation in the discussion of all reports, and stressed the value of the association to maintenance of way men in the solution of their many and ever-increasing problems. "The Roadmasters and Maintenance of Way Association," he said, "has long been doing outstanding work among practical maintenance officers. It stands high in the esteem of railway management by reason of more than 50 years of conscientious concentration on methods of track maintenance.

"Every alert roadmaster, track supervisor and member of a railway engineering department," he said, "should be affiliated with this earnest group of maintenance men, with whom they can fully discuss their problems. Now, more than ever before, it is necessary for roadmasters to prove to their managements that they are getting the most in results for every dollar they spend for labor and material. The Roadmasters Association, with its committee reports and discussions, offers up-to-date information on the ever-increasing troublesome problems which confront every track man. I know of no better way to develop practical men than for them to join our association, and to take part in its activities. It is from these men that the managements will secure many of their maintenance officers in the future. One of the important advantages of attending our convention is the

G. L. Sitton
Vice President

C. A. Lichty
Secretary

E. E. Crowley
Treasurer

Roadmasters Association

Officers 1938-39

F. B. La Fleur, president, roadmaster, S. P., Lafayette, La.

G. L. Sitton, vice-president, chief engineer maintenance of way and structures, Southern, Charlotte, N. C.

C. A. Lichty, secretary, Chicago.

E. E. Crowley, treasurer, roadmaster, D. & H., Albany, N. Y.

Executive Committee

W. O. Frame, past president, superintendent, C. B. & Q., Centerville, Iowa.
(Terms Expire September, 1942)

F. J. Liston, roadmaster, C. P., Montreal, Que.

R. S. Kniffen, general roadmaster, G. N., Duluth, Minn.
(Terms Expire September, 1941)

A. B. Hillman, roadmaster, Belt Ry. of Chicago, Chicago.

E. L. Banion, roadmaster, A. T. & S. F., Marceline, Mo.
(Terms Expire September, 1940)

R. L. Sims, assistant superintendent, C. B. & Q., Wymore, Neb.

W. H. Haggerty, track supervisor, N. Y. N. H. & H., New Rochelle, N.Y.
(Terms Expire September, 1939)

R. H. Carter, division engineer, I. C., Chicago.

J. J. Clutz, acting assistant division engineer, Penna., Jersey City, New Jersey.

opportunity which it affords to visit the educational exhibit presented by the Track Supply Association, and to study and discuss the uses of the various roadway machines and materials displayed and their advantages.

"This Association is confronted with constantly changing conditions, and especially since the demand for higher speeds of both freight and passenger trains. We have not been lacking in our efforts to cope with this situation, and it is our aim to carry on in keeping with the accomplishments of our predecessors."

Safety Can Be Achieved

By R. H. SMITH

Vice President and General Manager, Norfolk and Western

It is generally recognized by all progressive modern industry that for an industry to attract and hold competent, desirable workmen, it must make their work safe. The railroads are a modern, progressive industry. At this time in history when an important part of the world is engaged in a war which has as its object the destruction of life and limb, it may seem futile for us here to be concerned with preventing even major injuries to our workmen. But, for many years I have believed in the value and importance of accident prevention work, and I am today just as firmly convinced that it is an essential of any successful business.

Last year there were 15,470 personal injury casualties among all railroad employees in the United States, and 3,602, or 23 per cent of these were among the maintenance of way forces. The casualty rate for all railroad employees was 6.86 per million man-hours, while for maintenance of way workers alone the rate was 8.11, or 18 per cent greater. Obviously, therefore, the prevention of maintenance of way accidents is a matter of importance.

Improved Record on N. & W.

The railway with which I am connected is proud of the fact that twice in the last 13 years it has been awarded the Harriman medal for the most outstanding safety record among the Class I railroads of the country—for the greatest progress in accident prevention. A substantial help in effecting those enviable records has been a large reduction in accidental injuries to maintenance of way men.

The Interstate Commerce Commission did not start keeping a separate record of injuries to railway employees by occupations until 1924. In that year the casualty rate among maintenance of way employees on the N. & W. was 26.7 per million man-hours worked. The rate for all Class I roads in that year was 27.5, approximately the same. Steadily and consistently we have lowered our rate, until in 1938 it was 3.71, 54 per cent better than the national rate of 8.11 for that year, and 86 per cent better than our own rate in 1924.

R. H. Smith

How was this improvement accomplished? By doing two things—by building up safety morale and by attacking accidents at the roots of their causes. As maintenance of way employees are widely scattered, safety educational work among them is difficult. While the aggregate danger to them is perhaps no greater than that to other employees, the hazards to which they are exposed are more varied and more numerous. They do all kinds of work, in all kinds of places. For these and other reasons, the prevention of maintenance of way accidents requires the application of unusual amounts of interest, energy and ingenuity. Fortunately, we can always find these three qualities in maintenance of way supervisory officers.

Must Interest Foremen

The first man whom we attempted to interest in safety on the N. & W. was the foreman. He is almost continuously with his men, actively directing their work. On his attitude and interest, we realized, depended whether or not the work would be done safely. So we concentrated our educational efforts first on him. His response was most gratifying to us.

We recognize in a suitable way foremen who bring their gangs through one, two, three or more years without lost-time injuries to any members of their gangs. On the first day of each year every foreman puts a large sign on his tool house or tool car reading "No Accidents This Year." This stays there until an injury to a member of the gang breaks the record. It is a "flag" of the safety cause that no foreman wants to lower. We convinced the foreman that the management was sincere in its admonition to do every job the safe way, even though it took him a little longer. And when we had him really sold on the idea that safe work was good work, and really interested in competing with his fellow foremen for good safety records, the morale of the "army" was established. Morale is just as much a help in winning a battle against accidents as it is in winning any other kind of battle.

Rail-Handling Accidents Reduced

Next came the attack on the accidents themselves. This attack was made on the roots of the causes from which accidents grow. It was first planned by a patient and thorough analysis of each individual accident to determine how it happened and its causes. The accidents were then classified by their causes and a determined drive was made on those causes, starting first with those which were producing the most accidents. Maybe the cause was an improper tool or machine or some other condition. Maybe it was an improper or careless practice. Perhaps, and often times, it was a combination of both. But whatever it was, we diagnosed it and then tried to correct it. It took patience and persistence, but the results speak for themselves.

On the average railroad, the handling of rail causes, or at least used to cause, more accidents in the maintenance of way department than any other one operation. There were 120 injuries from this cause on the railways in 1924. In 1938, there were

only 3 from this cause, a reduction of 98 per cent. The average rail in 1938 was of larger section and longer and heavier than the rail handled in 1924. The difference in the number of accidents was the result of better rail-handling equipment and more intelligent care in the work.

I can remember when it was accepted as inevitable that rails would occasionally slip in the rail tongs when being lifted by a crane. When a man was hurt in that way we regarded it as something which was too bad, but which couldn't be helped. But when we realized how many accidents were happening from this cause, we began to study rail tong design and, after considerable experimenting, developed a type which gripped the rail so that it didn't slip, and accidents of that kind stopped.

Special Precautions Taken

I remember years ago when, in picking up rail from the ground with a work train, the most active man in the gang was selected to stay on the ground, and the quality of his work was gaged by the speed with which he could slip the tongs over the ball of the rail. He was expected to be a fair guesser as to what was the center of the rail, but entirely too often he got his tongs off center, with the result that one end of the rail swung up while the other stayed on the ground, with the hazard of accident which this presented in the possibility of the unbalanced rail slipping. Today, in advance of such work, two men go over the rail with a tape line and a piece of chalk and mark the center of every rail, eliminating the guesswork as to their centers and the hazard of accident from picking up an unbalanced rail.

I can remember when the skill of the crane engineer was gaged by the speed with which he could lift a rail from a car, swing it over the side and drop it to the ground. In this work, many operators trusted to the alertness of the men on the ground, and largely to luck, that no one would be under the rail as it was being unloaded. One day I saw a 130-lb. rail being handled in this manner dropped on a man who failed to get out of the way quickly enough after running in to pull a rail that had just been unloaded off the ends of the ties. That was 20 years ago, but the picture of it is still clear in my mind. Today, when unloading rail, a man is posted at the end of the rail car with a clear view of the crane engineer, the men in the car, and the men on the ground, and the crane engineer makes no move except on a signal from this man. As a result of this practice there has been a reduction of 98 per cent in the number of accidents occurring while handling rail.

The next most prolific cause of injuries on our railroad in 1924 was in the handling of ties. In that year we had 99 accidents from this cause, resulting in mashed or broken fingers and toes, and broken arms or legs. In 1938 we did not have a single injury from this cause. Why? It is true that we handled fewer ties in 1938, but we still handled a considerable number. In 1924, our men said that the large number of accidents was due to the fact that the ties were creosoted, many being still wet and slippery with oil when inserted in the track, and that you just couldn't help having some accidents. At that time, it was the practice to stick the point of a pick into the tie to pull it into place under the rail. That was bad for the tie and it was worse for the workman if the pick slipped out and he fell back across the rail.

To overcome this hazard we provided tongs for pulling the ties into place, but the points of the tongs wore dull and smooth and the workmen still fell when the tongs slipped. Then we had the points of these tongs made of a high quality steel and issued instructions that they be kept ground sharp. Furthermore, our inspectors going over the road at unexpected times inspected these tongs to see if the points were sharp. As a result, there was not a single injury from the handling of cross-ties in 1938.

Few Motor Car Accidents Now

Like many other roads, starting about 25 years ago, we began to equip all maintenance of way gangs with motor cars. These cars promptly became an outstanding cause of injuries to employees. In one year we had 8 employees killed and 97 injured in motor car accidents. Last year we had only 6 injuries from this cause, a reduction of 94 per cent, and only 3 of these occurred in motor car collisions or derailments, the other 3 occurring during the handling of cars on or off the track. The improvement in the record was the result of the adoption and enforcement of sensible rules governing motor car operation, and the improvement of those features of the motor car which contributed to accidents.

The first free-running engine cars had detachable starting cranks which frequently flew off, often breaking teeth or bones. In a change the cranks were permanently attached, and this class of injury disappeared. We used to have tools fall from cars, sometimes in front of them, and cause accidents. In one case where a lining bar slipped off the front end of a motor car loaded with men, the bar stuck in a tie, threw the car off the track and killed four of the men and injured two. As a result of this accident we had tight tool trays of adequate size put on cars and required that only such tools be handled on the cars as could be loaded without the possibility of their falling off. This ended that class of accidents.

We used to have frequent injuries to men, caused by slivers of steel flying from rail, chisels, bolt heads or striking hammers. One year we had 13 such accidents, injuring men to such an extent that they lost more than 3 days time, including 6 men who lost eyes. Many of you can remember the day when it frequently took a half dozen chisels to cut a rail because the point would chip off, and how, if the point was good, the head was often so soft that it "mushroomed" so that an off-center blow could cause a sliver of steel to fly. You can remember also how spike maul heads used to mushroom.

The question was what could be done to prevent this? We called on the manufacturers to produce a better chisel, kept test records of various ones and bought only those which gave satisfactory performance, even though they cost more. Furthermore, we provided every maintenance of way gang with a simple emery grindstone and required that they keep the heads dressed on their chisels, spike mauls, and other tools against mushrooming. As a result, instead of 13 injuries last year, with 6 eye losses, we had only 1 comparatively minor accident from such causes.

Never Be Satisfied

I am a believer in a definite set of printed safety rules. I have never thought it fair to issue a safety rule by a circular letter and from then on to hold the men affected responsible for remembering that once-issued instruction. Many years ago I sponsored, and our road adopted, a printed booklet containing the more important safety rules and instructions, a copy of which was put in the hands of every employee. I am sure that we have secured substantial results in increased safety from the adoption of these codified safety rules.

Another thing that I want to urge is that no matter how good a record you make, never be satisfied with it. Let each new record be a starting place from which to build a better one. In 1926, when our road was first awarded the Harriman medal, we had 1,439 accidents, with a casualty rate of 18.49. It was the best record we had had and at the time we were proud

of it, but we weren't satisfied. It wasn't good enough. Steadily through the ensuing years that record was improved until last year, in comparison with 1926, the total number of accidents was reduced from 1,439 to 150, or more than 89 per cent, and the casualty rate was reduced from 18.49 to 3.95, an improvement of more than 78 per cent. This same improvement can and is being made on practically every other railroad in the country, and is one of those things about which the American railroads and their employees are justly proud.

Heaving Track—Its Causes, Control and Maintenance

Report of Committee

L. J. Gilmore
Chairman

THE heaving of track during the winter season is a well-known phenomenon on the railroads located in the northern part of the United States and in Canada. It presents a serious problem to the maintenance officer whose duty it is to maintain smooth-riding track when the roadbed is frozen, particularly now, since both freight and passenger-train schedules are being shortened, and winter maintenance must keep pace with these faster schedules.

Little Heaving on High Fills

Heaved track is track that becomes out of surface after the ballast and roadbed are frozen and is caused directly by the action of the frost on the moisture present in the ballast and the roadbed soils. Water expands about 8½ per cent by volume when it freezes. Such an expansion of the moisture in saturated roadbed soils sets up a tremendous internal pressure which distorts the soil in the direction of least resistance, which is upward, and this action affects the surface unevenly and causes what we term "heaved track." This action by the frost attacks the track at places where there is an excessive amount of moisture present in the roadbed and occurs most frequently in wet cuts, low fills, at road crossings, at switches and at other locations that are not drained properly.

Heaving has many harmful effects on both operation and maintenance. Speed restrictions placed over uneven track interfere with and slow down train schedules. Fast-moving trains over uneven track may result in damage to equipment, such as broken trucks or waste grabs that cause hot boxes, which may result in burning off journals and subsequent derailments. Heaved track also causes increased winter-maintenance charges by reason of the necessity for furnishing, placing, maintaining and removing track shims. There is also danger from broken rails and joint bars, damage to ties and fastenings, danger from spread track and, generally, a much weaker track structure.

Heaving seldom affects track to any appreciable extent on medium or high fills for the reason that on high fills the roadbed is usually well crowned and natural precipitation drains off readily, and the roadbed is sufficiently above the water table for capillary water not to affect it. If heaving does occur on a fill, it usually results from the presence of a water pocket or it is light early heaving caused by foul ballast.

A study of the locations where heaving occurs will reveal two facts: (1) That there is an excessive amount of moisture in the roadbed; and (2) that the character of the soil of which the roadbed is made is one that will hold free water against gravity and will also cause moisture to raise in it by capillary attraction from a lower water table.

Origin of Water

We will discuss first the origin of the water found in wet roadbeds. This may come from one or more of the following sources:

(1) Natural precipitation (rain and snow)
(2) Overflow from higher areas
(3) Side-cut or side-hill seepage
(4) From the presence of springs
(5) From the natural water table

When it has been determined definitely which of these sources is causing the excess moisture, the next step is to prescribe a proper form of drainage. The cure for heaving is drainage, control or removal of the troublesome water. Adequate drainage is the most important part of roadbed construction and represents an economical investment in that it insures the avoidance of high maintenance expense in the future. The drainage system should be designed to take care of both surface and sub-surface water.

Source No. 1: Natural precipitation. If this water is allowed to stand on the surface, a portion of it evaporates and the remainder seeps into the roadbed. If the roadbed is well crowned, the greater part of the water will drain off quickly, instead of evaporating or soaking into the roadbed. The next step is a well-maintained surface ditch on each side of the roadbed, with a proper grade line that will carry this water to a natural outlet. This is surface drainage.

Source No. 2: Overflow from higher areas. When a cut is made, the contour of the natural ground is changed and sometimes natural waterways, usually small gullies, are intercepted. These may be dry the greater portion of the year but after rains and during the spring run-off they may have water in them, the water from these higher areas being thus diverted into the cut, and provision must be made to keep this water from coming in contact with the roadbed. In such cases, the engineering department should run levels and install intercepting surface drains above the cut to intercept this water and carry it away before it reaches the roadbed.

Source No. 3: Side-cut and side-hill seepage. This results from certain ground water being intercepted, which causes seepage. Such water should be carried away to a natural outlet by surface ditches located well below the elevation of the subgrade.

Sources No. 4 and 5: Water from the presence of springs and from the

natural water table. Water from these two sources is naturally the most difficult to overcome and also causes a large part of the trouble with heaving. In these cases surface ditches are not effective and it is necessary to resort to subsurface drains. The ground-water level may be so close to the subgrade that the water raises into the subgrade soils by capillary attraction in the same manner that kerosene raises in a lamp wick. Water in these levels is slow moving. The proper remedy is to install subdrainage to a depth that will lower the water table, so that capillary water will not get into the subgrade soils, and to establish a grade line that will increase the flow of water from this underground area (reservoir).

Character of Material

We now go back to the character of the material of which the roadbed is made. This, too, will be found to be of utmost importance in this discussion. Until about 25 years ago, little, if any, research was carried on in regard to various soils and their suitability for subgrade uses. With heavier train loads and heavier locomotives, moving on faster schedules, a demand for a stronger track and a higher class of maintenance became necessary. A careful study of these matters brought the conclusion that to improve track required not only heavier rails, larger ties, stronger fastenings and deeper ballast, but also a more stable roadbed and better drainage systems. Further research developed the fact that certain soils resist drainage and are not as suitable for subgrade uses as others. This research has led to soil studies and soil classifications which are now carried out extensively by railway engineers and state and federal highway engineers. The foremost of these probably is the United States Bureau of Soils which has sampled, tested and classified the soils from the greater portion of our country.

These studies of factors in railway and highway foundations show definite prospects of benefit and we quote the following from a recent text book on soil studies and drainage:

(1) The adverse character of subgrade soils depends primarily on the volume change caused by variations in moisture content, or frost action. The main adverse action of the volume change occurs in one direction which is vertical. Heaving of track or an uneven swelling by reason of these accumulations results.

(2) The volume changes distort the subgrade, which displaces the surface unevenly and subjects it to excessive localized stresses. (This is the explanation of heaving.)

(3) The adverse character of the subgrade soil is shown to increase with the clay content.

(4) The clay content and adverse character of the subgrade soil are indicated by certain simple and practical field tests called the field moisture and shrinkage tests.

(5) Generally speaking, sands, sandy loams and silt loams are considered good subgrade soils, while sandy clay loams, clay loams, silty clay loams and silty clays are doubtful subgrade soils and clays are bad subgrade soils.

All soils are of mineral origin, being formed by the disintegration of rocks, through the agency of wind, water, ice, frost, temperature changes, chemical action, plant growth and animal life. In addition, soils contain organic matter extracted from the air and from vegetation which has grown in the soil. Also there are many forms of minute animal life in the soil, which influence drainage.

Subgrade research emphasizes the fact that excess moisture in subgrade soils is, in most cases, the cause of unsatisfactory support and is the cause of rough track when not frozen and causes heaved track when frozen.

Proper Drainage Will Do Much to Prevent Heaving Track

Soil Moisture is Harmful

In dealing with soils for roadbed use we consider two principal kinds of harmful soil moisture:

(1) Gravitational water. This is water that is free to move under the influence of gravity. It enters or leaves the subgrade by gravity, seeping through the pores of soils or through cracks and channels formed by insects, etc. The porosity of the soil controls, to a large extent, the rate of flow. Gravitational water can usually be removed by drainage.

(2) Capillary moisture clings to the soil particles by surface tension and passes through the soil by capillary attraction from wet to drier soils. It is not affected by gravity, being able to move upward or horizontally and cannot be removed by drainage but can be controlled by lowering the water table. This water can be removed only by heating, evaporation, freezing or subjecting the soil to great pressure.

The amount and proportion of free and capillary water which can exist in a soil depend in part on the size of the pores in the soil and the permeability of a soil depends upon the readiness with which a liquid will pass through it.

The moisture-holding ability of a soil and its suitability for subgrade uses vary with the size of the soil particles. The smaller the soil particles and the finer the soil pores, the greater is its moisture-holding ability and also the greater is its capillary attraction.

The result of this research develops three fundamentals that interest us in this discussion.

(1) Clay soil will hold more moisture against gravity than any other soil.

(2) Clay soil, because of the fineness of its pores, has more capillary attraction, which causes water to rise in it above the water table.

(3) Clay makes the poorest foundation for a roadbed.

Excess moisture in subgrade soils makes an unstable foundation. It decreases bearing value during the summer months and causes unequal heaving during the winter period.

Where Heaving Occurs

Soils that are thoroughly dry will not heave when frozen and therefore have no appreciable shrinkage when the frost goes out, for which reason dry soils are the most satisfactory for railway foundations. However, the poorest of soils can be transformed into stable subgrade material by removing the moisture from them.

In the study of heaved track it is found that usually the same places heave year after year, or until proper corrective measures are applied. We know this to be a fact, since shimming records have been kept on the profiles on some of the larger railroads and it was proven that the same places heave year after year. Again, it has been shown that, because of inadequate subgrade support, extremely unsatisfactory conditions are present during the time the frost is out of the ground, which result in greater train resistance and operating costs. Furthermore, wave motion of the track over these inadequately-supported areas causes additional rail creepage which,

in turn, causes increased mechanical damage to the ties, shortens the life of the rail and fastenings, increases danger from broken rails and angle bars, creates churning joints and track and necessitates frequent levelling and lining, all of which are the direct result of inadequate drainage.

If steps are taken to correct the winter roadbed heaving, they will not only improve winter riding conditions and lessen winter maintenance costs, but will greatly strengthen and improve the track structure during the remainder of the year and, in addition, will show a substantial saving in labor and material expended annually on maintenance.

These track maintenance problems are among the most troublesome with which maintenance men are confronted. If an accurate record were to be kept of the charges resulting from excessive maintenance at these troublesome locations, it would most certainly prove that the expenditure necessary to control or to cure the trouble would be a worth-while investment and would be justified.

Heaving Can Be Cured

At this point we make a bold statement: With very few exceptions, heaving can be cured. Some cases can be cured with reasonable expense, while it is true that at other places considerable expense will be involved.

To enable us to discuss the control and cure of heaved track more understandingly, we will divide heaving into three classes: (1) Early winter heaving; (2) late winter heaving; and (3) combinations of both. Likewise, we list the more common controls: (1) Surface drains; (2) subsurface drains; (3) application of ballast and surfacing the track; (4) the removal of troublesome subgrade materials and backfilling with a more pervious material; and (5) raising the roadbed to a level sufficiently above the water table to prevent capillary water from having any effect.

Early heaving in the northern states and in Canada occurs usually from December 20 to January 10, when the frost has penetrated from 12 to 18 in. into the ballast and surface of the roadbed. This heaving is usually light and requires shims from ¼ to 1 in. in thickness to restore smooth rail. We attribute this early winter surface heaving to the fact that the ballast material is old; has lost its permeability; is badly fouled with wind-blown dirt, decayed vegetation and animal life; to the further fact that as a result of those conditions the track is pounded down and probably has not had an out-of-face lift for a long time, so that the ballast has lost its effectiveness for maintaining drainage to such an extent that it retards the flow of free water against gravity, and the autumn rainfall is held in it. When this water, accumulated in the ballast and on top of the subgrade, freezes it causes uneven surface heaving, much of which is so slight that it cannot be shimmed, yet is sufficient to cause choppy-riding track.

This type of heaving is recognized readily by an experienced trackman and usually requires no extensive study to determine its cause. Stretches of track thus affected may be treated successfully by giving it an out-of-face lift of from 10 to 14 in., using a clean, sound, porous material for ballast. The old ballast shoulder should be cribbed out to a depth of 3 in. below the bottom of the ties and spread over the top of the subgrade. This treatment will restore drainage to the ballast and ballast shoulder; the free water will not be impounded near the surface; and the ballast will go into the winter reasonably dry, which should eliminate or reduce the heaving and also provide a more stable track during the entire year. Churning joints will be corrected, line and surface will be uniformly better, and the benefits derived will be greater than the expense involved.

Late winter heaving and combinations of both early and late heaving occur after the frost penetrates to its maximum or approximate maximum depth into the roadbed, and is caused, as explained previously, by the uneven distribution of moisture in saturated roadbed soils. Before permanent corrective measures can be applied, a thorough study is necessary to determine the source of the moisture and the most practical and economical method to eliminate it.

Studying Subsurface Water

Consideration must be given to (1) the location, whether in a cut, on a fill or side hill, etc.; (2) to the elevation, that is, whether the roadbed is sufficiently above the surrounding area to make subsurface drainage feasible; and (3) to the character of the soil of which the subgrade is composed.

We are now getting into more expensive controls and extensive study becomes necessary before the decision as to the proper remedy can be made. We will take it for granted that surface water has already been eliminated by well-crowned roadbeds, surface drains, etc., and that our difficulty is caused by conditions below the surface.

With respect to well-crowned roadbeds, we might mention here that experience has shown that although the roadbed was built originally with an adequate crown, this crown does not always remain, especially if the roadbed is made of clay. In time such roadbeds become dished, with the maximum distortion usually occurring under each rail, thereby forming two water pockets. A condition such as this may be largely overcome by placing a heavy blanket of sand or sandy loam over the clay to act as a foundation for the ballast. This practice will maintain a proper crown on the roadbed, will shed natural precipitation and will also be effective against capillary water.

As we have stated, we believe that most of our heaving is caused by troublesome ground water. The practice so often indulged in, of guessing where to place subdrains and their depths, has admittedly created doubts in the minds of railway managing officers as to their value. It is entirely reasonable to believe that if free ground water is located and is then intercepted and drained off, the harmful effect of capillary water in our roadbed soil will also be eliminated.

Finding the Water Table

Tests to locate accurately the depth of the water table and also to obtain samples for the soil survey, can be made with a simple soil auger, similar to a post hole auger, with a bit 2-in. in diameter welded to a section of standard ½-in. pipe, with several extensions of 2 or 3 ft. in length. The best time to make ground-water investigations is during the wet season, because then the worst conditions prevail.

When the depth and location of the water table have been determined accurately, the next step is to run levels to determine whether there is sufficient elevation to provide a drain to a lower area, with enough fall to insure run-off. If this is found possible, we then recommend the installation of subdrainage, with sufficient lateral and parallel lines of subdrainage to conduct the water out of the troublesome area, as the soundings indicate will be necessary, or as each specific case may warrant. These lines should be placed at a depth that will insure the lowering of the water table sufficiently to prevent the capillary moisture from raising into the subgrade soils and to intercept any free gravitational water that might seep in. The backfill in the subdrainage trench should be pit-run gravel which will aid in intercepting surplus surface water and also free water and carry it to the lower area where it can be disposed of readily.

It should be kept in mind that the water table is an undersurface reser-

voir fed from springs and free water and is not fast water; that is, it flows slowly; and that the installation of sub-drainage will do no appreciable good unless it lowers the water table and has a gradient which will increase the flow from this area.

If the area surrounding the troublesome spot is at a higher elevation, there is little chance for sub-drainage, because there is no place for an outlet for the run-off. At such places we recommend that the surface ditches be widened and deepened and that the grade of the roadbed be raised, using a previous material of low capillarity, preferably sand or gravel. The roadbed should be raised on such material to the extent necessary to prevent capillary water from reaching up into the roadbed to a point above the frost line. Investigation will develop the height of the raise necessary to do this.

These latter cures may run into considerable expense, and, as stated, should not be attempted unless study has developed that the return will be justified. In some cases, generally found in cuts, violent heaving occurs at only one or two places in the cut. In these places one sometimes hesitates to recommend subdrainage because of the cost, although subdrainage would be certain to correct the trouble. At these spots it will be found that the soil is clay, or predominately clay, and resists drainage. At such points we recommend the digging out of this unstable soil to a depth of six to eight feet and replacing it with sand, gravel, or other pervious material.

There are, of course, special cases and exceptions where an installation of subdrainage is not feasible; also because of location, the roadbed cannot be raised and the track cannot be lifted out of face. The only alternative for such places is the removal of the unstable roadbed soils and replacement of them with good pervious material, being sure to remove the unstable materials to a sufficient depth and width.

Shimming Is Unproductive

We believe we have covered the causes and cures for surface heaving of track and will pass on to the maintenance of these sore spots. On those roads located in the northern part of the United States and Canada, the methods used in shimming heaved spots is substantially the same. Therefore, we will not take the time to explain how to place or to remove shims, but only to say that this is, at its best, a makeshift method of getting by and a needless and unproductive outlay of labor and material. When the shimming has been completed, the track has not been improved in the least, and the ties have had their service life considerably shortened. For this reason, we offer the following suggestions, looking to a reduction in the number of shims necessary to place, and also mention certain fundamentals to follow in placing and removing shims.

(1) We recommend that all surface ditches be cleaned and well maintained and that intercepting ditches be given the same attention during the summer season, to insure full benefit during the wet season; that these drains be given sufficient fall with no flat spots; and that they lead to a natural outlet.

(2) Late in the summer, the spot that heaves should be given a light out-of-face lift of one to two inches and the track should be placed in proper line.

(3) If track is boxed in so that natural precipitation stands on the surface, we recommend that the track be given an out-of-face lift, leaving considerable crown to the ballast shoulder to insure a better run-off from the late fall rains.

(4) Certain places where heaving humps occur during the winter can be marked and the track can be dug down late in the fall, placing summer shims on the ties so dug down. These shims can be reduced and removed as heaving progresses. Oftentimes summer shims placed on 6 to 10 ties where the summit comes will eliminate shimming for as much as two or more rail lengths.

(5) For best results in applying shims, we suggest that the high rail be smoothed first, and that the low rail be brought to level, being sure to maintain good line and uniform gage at all times.

Properly Maintained Track, With Clean Ballast, Usually Causes Very Little Trouble Because of Heaving

Conclusion

In closing, the committee wishes to emphasize that there is no substitute for a stable substructure for the track. An increase in the weight of the rail will strengthen and stiffen the track structure, but increases in moisture content greatly decrease the bearing value of the subgrade. The allowable bearing value of a wet clay subgrade is less than one ton per square foot, while dry clay normally has an allowable bearing value of more than four tons per square foot. We believe that expenditures to cure heaved track will prove worth-while investments on any railroad and that such expenditures will pay dividends in decreased maintenance costs.

Committee—L. J. Gilmore (chairman), div. rdm., G. N., Superior, Wis.; L. P. Chicoine (vice-chairman), rdm., C. P., Vaudreuil, Que.; E. G. Brisbin, supv., M. C., Jackson, Mich.; H. H. Britton, supv., N. Y. C., Adrian, Mich.; W. J. Daehn, rdm., C. & N. W., Sparta, Wis.; J. Ferguson, div. engr., C. N., London, Ont.; J. E. Johnston, rdm., S. P., Douglas, Ariz.; F. J. Liston, rdm., C. P., Montreal, Que.; H. P. Mason, supv., B. & M., Boston, Mass.; P. F. Muller, rdm., C. & W. I., Chicago; S. J. Owens, asst. engr., C. B. & Q., Chicago; I. D. Talmadge, rdm., N. Y. O. & W., Oneida, New York.

Discussion

Referring to the statement in the report advocating the use of sand as a means of preventing heaving, President La Fleur suggested the possibility that the application of a blanket of such material to the roadbed might cause water pockets. Answering, Chairman Gilmore explained that such materials as clay retain free water and, hence, when wet they lose much of their bearing power; sand or cinders, on the other hand, retain their bearing power when wet. In the application of sand or cinders to the roadbed, however, care should be taken to insure that the crown of the subgrade is retained, or is restored if it has been destroyed.

A. Chinn (Alton) explained that if the depth of a water pocket is not below the side ditches the subgrade can be restored with a pervious material, such as sand or cinders. He also called attention to the fact that, since locations where heaving occurs are usually the scene of soft spots in the summer, measures taken to prevent heaving also cure the soft spots, thereby further reducing maintenance charges.

F. J. Liston (C. P. R.), a member of the committee, read a brief paper describing the use of chemicals, such as salt, as a means of curing heaving at locations where drainage is not feasible. Because of capillary action, he said, fine-grained soils show a greater tendency to heave than coarse-grained materials. By such action, he explained, the fine-grained soils draw water above the drainage outlet and, hence, it is not feasible to dispose of the water by drainage. With the object of finding a solution for the problem of heaving in such soils, he said that extensive tests have been conducted to determine the efficacy of chemicals for this purpose. These tests have shown that the temperature of the soil does not approximate that of the atmosphere, being considerably higher in the winter, and that if a low concentration of an anti-freeze material, such as salt, can be built up in the soil, freezing can be prevented. In actual practice, he said, the rule is to apply a thickness of salt to the roadbed equivalent to that of the shims (up to 3 in.) that would otherwise be required. To prevent rough track, the salt is "feathered" out at the ends.

Mr. Liston described two methods that may be used for applying the salt. In one of these it is spread on top of the roadbed and worked out of sight with tamping tools, while in the other the ballast is removed from the cribs and the salt is applied at or below the bottoms of the ties. He said that the salt must be applied sufficiently in advance of the winter months to permit it to achieve the proper degree of distribution in the roadbed, the summer or early fall being the best time.

P. Chicoine (C. P. R.) emphasized that the only permanent way to prevent heaving track is to remove the cause by drainage, and said that where this cannot be done chemicals are the only other remedy available. This method has been used extensively on his road, he said, and reports have been tabulated in detail showing the savings as compared with the cost of shimming the track.

A brief résumé of the experience of the Canadian roads with the use of chemicals in the prevention of heaving was presented by G. R. Chambers (Canadian Industries, Ltd., Salt division). He said that to date only two substances, salt and calcium chloride, have been used but that other substances, such as sugar, that lower the freezing point of water are also applicable. In Canada, he said, the entire country "heaves" to some extent but that at certain points the heaving is greater than at other locations and it is at these points that chemicals are being used. Whether or not the chemical method is economical, he said, depends on the cost of shimming. In putting the method into practice, he said that the first application on a given section is supervised closely, after which the foreman is permitted to use his own judgment in making the installations. With this method the results for the first year are usually about 50 per cent satisfactory, while the average for the second year is 75 per cent and after that it is usually above 90 per cent.

In closing the discussion, G. L. Sitton (Sou.) called attention to the fact that much of the report would apply equally well if the words "rough track" were substituted for "heaving track."

Specialized Versus Section Gangs

Report of Committee

J. B. Kelly
Chairman

IN our consideration of this subject we have started with the assumption that large specialized gangs are accepted as the most economical, practical and efficient means of accomplishing any considerable program of relaying rail or ballasting. Consequently, we find no occasion for much discussion of those larger gangs which fully utilize such labor saving devices as tampers, rail laying cranes and machines, heavy-duty power cars for handling men on trailers, power and heavy track cars for handling materials, and such special equipment as tie adzers, power spike pullers, spike drivers and bolt tighteners.

Specialized Gangs

The specialized gang is indispensable for carrying on maintenance work with equipment that has been introduced and has become a necessary adjunct in getting results. Specialized gangs are also necessary for the development of devices and appliances that must be encouraged and held in service, or discarded according to their merits. Such gangs are approved as satisfactory for such work as rail sawing with portable gas and electric saws, either under traffic or in stock piles; the welding of joints, frogs and switch points in track; surfacing track with a light lift to restore the track cushion (this work has been neglected in recent years, resulting in choppy, hard-riding center-bound track); tie renewals to the extent that may be economical; respacing ties; clearing right-of-way; small rail relay jobs, such as rail replacements on curves; and the interchanging of curve rail to prolong its life and to reduce the cost of spot surface maintenance and welding. Specialized gangs are also valuable in their availability for emergencies, such as washouts and other unexpected damage to track.

Assignments as mentioned, carried out by specialized gangs, may well develop the value of special tools and equipment. Most such tools and equipment could not be justified for section crews, however, as their intermittent and limited use would make them of little advantage over

former hand methods and save hardly enough to pay depreciation and interest on the machines. Most machinery, to justify its expense, must be kept in active service during the open working season, which in many parts of the country is limited to six or seven months.

The introduction of track grinders has made the one-torch welding outfit a rather expensive method of welding rail ends as it takes a torch crew's production to support the use of the grinders as well as the cost of motor car transportation.

Specialized Gangs Are Employed on Many Roads to Perform Out-of-Face Surfacing and Other Heavy Maintenance Work

At least one specialized maintenance gang of 15 to 25 men, in addition to section gangs, should be assigned to each track district and should be fully equipped with power tools for the work assigned to it. When there is a necessary variation in this arrangement, the major equipment should be employed by other gangs on the division or system in order to keep it in nearly continuous use.

The practice of using doubled-up section gangs for the distribution and picking up of relay material should be discontinued and the job should be turned over to specialized gangs to perfect efficiency and to utilize the time that is lost by section forces in traveling, thus allowing the section gangs to confine their efforts to regular section work. This will do away with the necessity for changing section gangs in the progress of distribution and pick-up work and will reduce accidents and injuries through the use of men of greater experience and efficiency.

Special Equipment

It has become self-evident that specially trained men are necessary for the handling of ballasting equipment and weed discers, track mowers, weed burners, bolt tighteners and joint-leveling machines, but the practice still exists of passing some of these machines from section to section. For example, we have information concerning mowing machines, which, in the hands of special operators, were kept going over a cutting territory of 1,200 miles, without delay for repairs, averaging more than 30 miles a day for six weeks, while on a former plan of section crew transfer, there were serious delays for repairs. From recent advice also, good results are being obtained on the Great Northern and the Union Pacific in tie renewals through the aid of power tie cutters and tie benders, which, employed with specialized crews of 25 men, have renewed as many as 450 ties per day in gravel ballast, or about 17 ties per man.

Section Elimination

It may be information to review the action reported by some roads in the elimination of sections and the application of maintenance gangs, from 1930 to 1939:

Delaware, Lackawanna & Western and Atchison, Topeka & Santa Fe—In 1930, these roads eliminated half of their section gangs as the result of advantages obtained through the use of motor cars.

Missouri Pacific lines in Louisiana & Texas—From 1928 to 1935, this road reduced its section gangs from 345 to 203; since 1935 it increased sections to 213; from 1928 to 1932 it reduced its floating gangs from 12 to 5; it increased its floating gangs in 1935 to 17; and increased floating gangs again in 1938 to 19. This road is now using 25-man relay gangs in heavy traffic. For work on single track, each of these gangs is equipped with two bolt tighteners and one power rail layer.

New York, New Haven & Hartford—In 1935 all sections were taken off this road and were replaced by 51 extra gangs consisting of 20 to 30 men each, 58 spotting crews of 3 to 5 men each, and 29 yard gangs of varying sizes. Over a three-month period with this organization, a substantial decrease was shown in the cost of supervision, overtime, and non-productive time, and a considerable increase in efficiency and production.

Chicago, Milwaukee, St. Paul & Pacific—In 1932 this road cut its section forces to one foreman and one man for each ten miles of main track and utilized specialized gangs. In 1936 specialized gangs on this road renewed 1,850,494 ties and section gangs renewed 1,114,104 ties.

Boston & Maine—In 1936 this road replaced all track walkers, except in terminals, by a foreman and one man who cover from 35 to 100 miles a day.

Chicago, Burlington & Quincy—Retains small section gangs of 3 or 4 men, but employs 15-man floating gangs to handle ordinary maintenance.

Erie—Reports that any increase in labor shall go to specialized gangs.

Chicago, Rock Island & Pacific—Increased length of sections to 9 to 12 miles; were formerly 6 to 8 miles. Track inspectors cover from 60 to 80 miles one way daily. They take care of switch lights, paint stand targets and derails, replace switch bolts and examine bridges and culverts.

Southern Pacific—This road uses specialized gangs for ballast and relay work. Section gangs do considerable spot surfacing, using 2 and 4-tool pneumatic tampers.

Great Northern—Cut off section gangs to reduce force. When additional allowance is made, the specialized gangs will be increased and possibly the section forces.

Lehigh Valley—Increased expenditures will be made in enlarging section gangs.

Central of Georgia—The number of section gangs were reduced from 226 in 1929 to 95 in 1932. From 1935 to 1937 they were increased to 110. Section gangs have 15 miles of main line and consist of a foreman and 6 men. Provision is made that practically no time is lost by section crews inspecting track.

The reduction in section crews has been offset by the introduction of specialized gangs on some roads, but in most cases the general reduction in the number of section gangs was made for financial reasons. This reduction was made possible, to a large extent, by the improvement in the track structure that had been taking place for some years before 1930. This was accomplished by larger investments in better ballast, heavier rail, treated ties, tie plates, rail anchors and ditching. Improved maintenance methods and an older, more solidified roadbed also were influencing factors.

The railways spent $800,000,000

annually for materials and upkeep in the seven-year period prior to 1929, including heavier rail, rail fastenings, and improved ballast. In some instances, from 15 to 18 per cent of the gross earnings were applied to maintenance work. The low figure of $322,286,000 for maintenance in 1933 was made possible to a large extent by the previous investments.

Heavier Rail and Treated Ties

As compared with 1915, the Lehigh Valley saved 1,000,000 man hours through the reduction in tie renewals, owing to the use of treated ties and heavy tie plates, this road having, after 20 years, 82 per cent treated ties in track, with a renewal average of 48 ties per mile in 1929. This road has purchased 136-lb. rail since 1916. From 1905 to 1915 an average of 131 track miles of lighter rail was laid, but with 136-lb. rail since 1916, the same rail results have been secured with an average of only 82 miles per year, in spite of heavier traffic. The effect of this in man-hours is shown in the following tabulation:

Test period	Total man hours	Man hours per mile of track, current repairs	Ratio of man hours each year to those of test period
1915-1917	10,496,749	2,960	100.0
1921	8,782,642	2,560	87.3
1927	7,665,376	2,170	74.4
1930	5,190,400	1,410	48.4

A road carrying 23,000,000 gross tons per mile per year reported 100-lb. rail lasting 5½ years, while 130-lb. rail has lasted 10 years and is still in service. The life of the rail was increased 50 per cent while the cost of the labor to lay it was 60 per cent less.

The Kansas City Southern reports reduced costs for labor by increased rail weights. Where the traffic was 3,000,000 gross tons per mile, a test on this road showed the following:

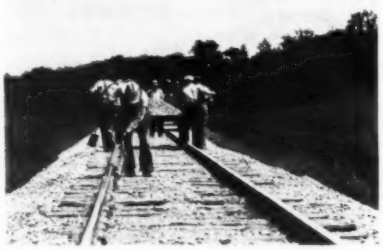
Rail Section	Labor per mile per year—man hours	Cost of labor per mile per million gross ton miles.
8521	3,150	$120
10025	1,950	74
11522	1,470	56
12722	1,280	49
15025	950	36

These comparisons are presented to show that reductions in maintenance, to a certain extent, were the result of employing heavier rail. The specialized maintenance forces should by no means be given any more credit for effecting economical upkeep than is due them. In many cases there is a trend to conclude that specialized gangs have had a large part in accomplishing work that is rightly the natural result of a better structure, older roadbed, better methods, and more production per man by all forces. Necessarily, the key to this situation is the greatest results of the same grade or standard that may be produced per dollar.

Section Gangs Have Place

The section gang has its function and, within its sphere, is necessary. Unfortunately, there has been some neglect in encouraging responsibility on the part of section forces, to an extent that they may be regarded simply as patrol and emergency units which cannot produce substantial results. The reduction in section forces was not due to their non-productivity, but rather to more permanent track construction and to the development of work equipment, and the full capacity of these forces must be retained and developed.

One of the great handicaps to the section gang on some roads is the necessity for making daily inspections of track, the care of switch lamps, the daily testing of highway signals and other trivial duties, so that they cannot possibly produce results. The regular patrol system of one road, employing one experienced, capable trackman and a helper, should be inaugurated on other roads, to cover 75 to 100 miles daily, especially in the open season, and take care of these duties. This inspection unit can ordinarily cover several sections for what it costs one section gang to go over its own territory.



A Section Gang Dressing Ballast on Track That Has Been Surfaced Out of Face By a Specialized Gang

As an example of what it costs an individual gang to inspect the track on its territory, let us assume a section gang including a foreman and 3 or 4 men. When making his daily inspection trip, the foreman does not ordinarily leave any men at the location of the day's work, both because he cannot be with them to supervise their work and because he may need them in handling the motor car. Therefore, the whole gang makes the journey, which may take from 3 to 4 hours at times when traffic interferes.

This is the main source of lost time on the part of the section gang. Control this waste and others of lesser consequence, and make it possible for the section force to compete in efficiency with any other organization in ordinary work for which a section crew is adapted. If the section gang, without special equipment, can put in as many ties per man and do it with an equal or better standard of workmanship than the specialized gang, there should be no objection.

We have data to show that section gangs working in gravel ballast are placing as many as 20 ties per man in 8 hours, and to a high standard of perfection. This same force is also entirely capable of making a running surface of a portion of the section each year, employing the troweling method, especially in gravel or similar ballast. There is no question about the effectiveness of the troweling method for spot surfacing because it has been the practice on high speed tracks in Europe for some time.

The section gang should be maintained for handling emergencies and for guarding the operation of trains. In some parts of the country and on certain roads in particular, there have been small washouts on an average of once or twice per week, which the section forces detect and repair promptly for train operation. Through the winter there are sleet and snow storm emergencies which the section gangs, properly increased in size, can handle instantly, these emergencies including the prompt restoration of telegraph communication where lines have been wrecked.

One of the prime duties of the track forces today is to follow track spotting in considerable detail to insure good surface and line. If this is not done, the track will deteriorate to the point where it will interfere with speed, and will require a great deal of unnecessary work to bring it back to good condition. This is strictly a section gang job.

Aids for the Track Forces

In addition to the importance of mechanizing the various gangs in track service, it is fully as important to secure the advantage of many other good features that result in improvement of the track and, incidentally, effect more lasting results from the labor expended on it. For instance, the ends of new rail are more noticeably off square today than they have been for ten years. In some cases it is evident that the sawing was not done accurately. In

other cases, the end hardening at the mills shrinks the upper part of the rail so that after it is laid in the track there may be an opening of ⅛-in. at the top while the bases are in contact. When such rail is under an expansion force, the end surfaces eventually contact, and there results a low joint, prematurely causing work, bent angle bars and a choppy surface. If the rail ends are off square transversely, kinked joints and bad local alinement result. The string lining of curves, employing the calculated method, and not the trial ordinate principle, has given good results in the restoration of curves. This method modifies the surface correction required and should be practiced in general.

Rather than cut necessary track labor because of financial inability to retain it, adjustments should be made in certain operating rules to permit the full use of work equipment that is being partially kept out of service because of the demand that full train and engine crews be employed where an operator and pilot are usually all that are needed. The adaptability of the small machine must also be given consideration in order that it may be available for certain types of work. Such a unit is the gas-powered three man track laying machine, which is entirely portable and which has a record of staying ahead of a crew of 135 to 175 men.

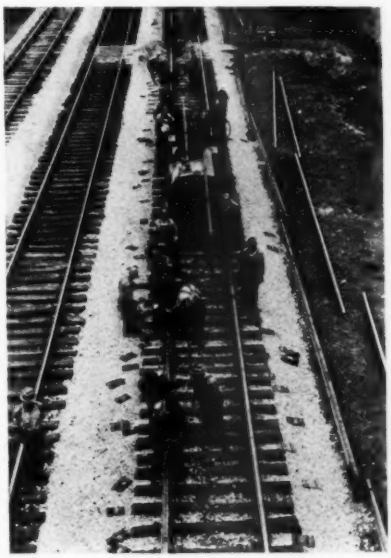
To compete with the section gang in bolt tightening work, it will be necessary to secure better results from bolt tightening machines than the records show. With the proper bolt assembly, a man with a wrench will condition at least a mile of bolts per day without danger of overtightening and over-stressing them.

In view of the type of railroads in this country, which are 90 per cent single-track lines with from 4 to 8 trains per day, the committee offers the following conclusions:

That any appreciable mileage of rail or ballast should be handled with large specialized extra gangs of about 135 men, fully supervised and equipped with machinery.

That at least one specialized maintenance gang of 15 to 25 men may be engaged profitably on each maintenance district and should be equipped with machinery and special tools for promoting the work in hand. The major items of machinery should be kept in transfer from gang to gang on the division, depending upon the working schedules of the gangs, so that these units will be kept in constant service during the work season.

That regular section gangs be maintained, and consist of at least a foreman and 3 men during the open working season, and that provision be made to employ them in a good share of regular section maintenance work—the mileage per section to be equated to the men allowed. Such



Rail Laying With a Specialized Gang

gangs should be released from regular daily track inspection by an arrangement of territorial inspection to include several sections, this inspection to be accomplished by a suitable foreman and a man of wide track experience, employing a motor car designed particularly for the purpose.

Committee—J. B. Kelly (chairman), gen. rdm., M. St. P. & S. S. M., Stevens Point, Wis.; J. M. Murphy (vice-chairman), rdm., C. M. St. P. & P., Sioux Falls, S. D.; C. E. Brown, rdm., P. & S. F., Slaton, Tex.; M. H. Dick, eastern editor, *Railway Engineering & Maintenance*, New York; J. H. Dunn, rdm., N. Y. C. & St. L., Ft. Wayne, Ind.; G. L. Griggs, rdm., C. B. & Q., Hannibal, Mo.; V. I. Kessinger, rdm., A. T. & S. F., Independence, Kan.; O. R. McIlhenny, ch. engr. and asst. supt., T. C. I. & R. R., Ensley, Ala.; F. J. Meyer, rdm., N. Y. O. & W., Middletown, N. Y.; W. H. Oglesby, supv., Sou., Camden, S. C.; G. M. O'Rourke, dist. engr., I. C., Chicago; C. L. Stuckey, rdm., M. P., Harlingen, Tex.; A. W. Wehner, rdm., S. P., Lake Charles, La.; W. H. Haggerty, supv., N. Y. N. H. & H., New Rochelle, New York.

Discussion

Armstrong Chinn (Alton) said that since the output per man per hour is practically constant, there are only two ways to get a gang to produce more work, one is to reduce unproductive time to the minimum; the other is to provide power machines to increase the output per man per hour. On the same basis, it is generally found that a section gang will do more and better work than a temporary specialized gang, because the section laborers are experienced men who expect to work steadily, while the temporary gang is made up largely of inexperienced men or itinerant laborers who have no interest in retaining their jobs after the particular work is completed.

F. G. Campbell (E. J. & E.) took the position that even with organized territorial inspection, the section foreman should not be relieved of responsibility for the safety of the track, and he feared that this might be the outcome of a system of inspection where the inspector had the responsibility for carrying out the track patrol over several sections. J. B. Kelly (M. St. P. & S. S. M.) replied that experience has shown that this does not happen and called attention to the fact that for many years foremen have delegated the track inspection to trackwalkers, adding that if the facts were known, there have been a multitude of cases where the track inspection has not been made simply because the foreman believed he did not have time to make it and that we are often working under a mistaken assumption when we believe that track patrol is being carried out consistently. Mr. Kelly added that in unusual weather it is expected that section foremen will go out and make a thorough inspection of the track under their jurisdiction as they always had done, regardless of any superimposed system of track inspection.

L. M. Denney (C. C. C. & St. L.), in discussing the specialized gang for ordinary maintenance, said that it is often a problem to organize such a gang for using power machines and tools when this equipment must be used without increasing an already inadequate force, because if enough men are supplied from the regular section organization, it means practically that the section gangs are stripped of men. V. E. Pearson (S. P.) called attention to the fact that for ordinary maintenance it is often uneconomical to organize a specialized gang since the size of such a gang for routine work may be small and the saving that can be made through the use of power machines is completely nullified by the fact that a locomotive engineman and a conductor must be placed on the equipment while it is used on the main track and that in some cases full crews, consisting of engineman, fireman, conductor and at least two brakemen are required, which may bring the cost of these unproductive employes to more than $40 per eight-hour day, and that often the saving normally accruing from the use of the power equipment is insufficient to offset this additional expense.

The Maintenance of Curves for High-Speed Trains

Report of Committee

C. W. Baldridge
Chairman

THROUGHOUT the more than a century since the railways became a factor in the transportation of persons and commodities, the maintenance of tracks has been an important feature in the successful operation of trains. Particularly, the maintenance of safe and good riding conditions on curves has been an ever-increasing problem, as the speed and weight of trains have increased.

That the forces acting on railway tracks are much greater when high-speed movements are being made than when the speed is low, is shown by the fact that the energy of a moving object increases with the square of the velocity of the movement. Thus, the energy of a train moving at 60 miles an hour is one-half the mass multiplied by the square of 60, or 3,600 times the mass. When the velocity of the same train is increased by one-half, that is, to 90 miles an hour, its energy becomes one-half the mass multiplied by the square of 90, or 8,100 times the mass, or 2¼ times what it was when the train was moving at 60 miles an hour. This great increase provides correspondingly greater forces acting on the rails, rail fastenings, ties, roadbed, bridges, etc., and it becomes necessary, therefore, to use much greater care in the maintenance of all of the elements of the track.

Curves call for a change in the direction of movement of a train and, since the laws of physics show that a body in motion in a straight line will continue to move in that straight line until acted upon by some external force, it becomes evident that a train will not follow a curve unless acted upon by a force not previously acting upon it. That force is provided by the resistance of the rails of the track, acting through the flanges of the wheels and thus changing the direction of movement of the train.

Since the centrifugal force acting on the train, like the energy which it develops through motion, increases with the square of the velocity or speed, we again find that the outward forces to be compensated for on curves are 2¼ times as great for a speed of 90 miles an hour as they are for a speed of 60 miles an hour. This fact makes it evident that curves must be so maintained that they will withstand 2¼ times as much punishment as they were required to undergo at the speed of 60 miles an hour. With these facts before us, it becomes evident that curves in a railway track which is to carry high-speed trains must first-of-all be laid out for high speed or must be changed to an alinement which provides spirals at both ends, along with an easement approach and runoff for the superelevation for the curve.

The following quotation is taken from page 5-34 of the Manual of the American Railway Engineering Association: "If physical conditions permit, the length of the easement curve should be based on a rise of not more than 1¼ in. per second," the "per second" referring to the rate of travel of equipment over the track.

As our subject is The Maintenance of Curves for High Speed, we will proceed on the theory that our curves have been put into such line, with the correct superelevation, as is needed for high-speed movements, and that it is our problem to maintain them in that condition. Therefore, the factors to be attended to are alinement, superelevation, surface of track, gage of track, replacing and re-spacing of ties (where needed), condition of rail, maintenance and trim of ballast, and drainage.

In the matter of alinement, the very great increase in the centrifugal force has two effects, (1) the movement of the track out of line, first, at spots where the superelevation is faulty, and (2), where the ballast support is weak. The correction of the bad line calls for lining the track to its correct center line. To permit this to be done accurately, the center stakes which were set when proper spirals and easements were established, should always be preserved so far as possible. When the center stakes have been removed or so disturbed as to be unreliable, they must be reset. High speeds for trains will not permit of half-way or makeshift measures, for a train moving at 90 miles an hour produces 2¼ times as much centrifugal force on a given curve as the same train produces at 60 miles an hour and it produces 9 times as much centrifugal force as it does at 30 miles an hour. It is essential, therefore, that the center line of the curve be staked with as much accuracy as possible.

Several variations of a method for stringlining curves were proposed a number of years ago and received considerable support shortly before high-speed passenger trains became an established feature of railway transportation. A search of engineering hand books, however, shows that the idea is of considerable age. The issue of Searles Field Engineering Hand Book, Sixth edition, published in 1885, which is the earliest copy the committee has been able to secure, shows methods of staking railway curves as follows:

(1) Deflections—transit and tape.

(2) Offsets from chords produced —tape line.

(3) By middle ordinates—stringlining.

(4) By tangent offsets—tape-line measurements.

(5) By ordinates from long chord —tape line.

The first of these methods is the usual one, in which a transit and a steel tape are used and the curve is run in from the beginning to the end. This method provides a positive check on the accuracy of the work by the closure on the stake at the connecting point of the curve and the tangent. The other methods can be used on new work but seldom are so used because of the difficulty in projecting the lines forward with any degree of accuracy.

The stringlining method, as now being advocated, is dependent on the line of rail already in the curve and

provides a check of the alinement by measurement of the middle ordinates of uniform lengths of chord. Stringlining is based on the fact that in a true circular curve the middle ordinates of uniform chord lengths of a curve are the same. It does not matter what length of chord is used, provided the same length is adhered to. Similarly, the staking of a curve by means of a transit and a tape line is based on the fact that the deflection angle to be set off on the transit is exactly the same for successive stations of the same chord lengths in any true circular curve. Offsets from chords produced are likewise equal for uniform chord lengths, while the staking of curves by tangent offsets and by ordinates from the long chords is possible because the offsets increase by the same amount at each successive offset point of the same chord length.

One feature of stringlining track on curves which most of its advocates urge, is that the middle ordinates of each chord length can be measured and recorded in a column and the irregularity of the curve is shown by the differences in the recorded measurements. It is also true that a transit can be set up over the gage line of the rail at the same starting point and the angular deflections can be read to each chord length and recorded. The difference in the deflection readings at successive points gives an even better indication of any irregularity of the curve, for the reason that the reading is taken at the gage line of the rail instead of at a middle ordinate length away from the rail, as is the case in stringlining. In addition, the average of the deflection from the beginning to the end of the circular portion of the curve gives the degree of the curve and the sum of the deflections from tangent point to tangent point shows the central angle of the curve.

Practically every writer of articles advocating the stringlining of curves claim for it "great accuracy" but none of them offer any proof of accuracy. Also, the advocates of stringlining claim that the great advantage over other methods is "its ease of compounding the curve to keep the throw of track to the minimum." The compounding is effected by using a larger or a smaller middle ordinate at any point where a shift of the center line is desired. It would be just as easy for a transitman to make the same shift of the center line by increasing or decreasing the deflection angle for the station or stations involved, but the transitman would recognize at once and no doubt admit that the process was that of "fudging the line." The compounds are usually small but so are the irregularities which are so detrimental to good riding track on curves. The ease of compounding is in fact a detriment rather than an advantage, because for high speeds real accuracy of alinement is necessary.

Another weakness of the stringlining method is the fact that it provides no check of its own accuracy, while the transit method shows what degree of accuracy, or lack of it, has been achieved when the final reading on the point of tangent stake is reached. Nearly all inaccuracies in staking the alinement of curves result from faulty measurements, and men who are inexperienced in chaining work will make some erratic measurements, even when using a steel tape. Good transits and steel tapes should be used for setting center stakes on curves in high-speed tracks, and they should be handled by experienced engineers. Roadmasters and trackmen have trouble enough of their own without burdening them with work which someone else should do.

Maintaining Superelevation

As already mentioned, the Manual of the American Railway Engineering Association gives a formula for the rate of increase of the elevation of the outer rail on a curve, beginning at the tangent-spiral point and increasing by exact amounts for equal chord lengths and reaching the full elevation at the point where the spiral curve and the central curve join. The formula most generally used is—

$$E = \frac{G\ V^2}{32.16\ R}$$ in which

E = the superelevation in feet
G = the gage of track
V^2 = the square of the velocity
32.16 = gravity acceleration, and
R = the radius of curvature

Each compounding of the curve made by any method of lining produces a change in the length of the radius and hence calls for a change in the amount of superelevation. Therefore, if a uniform amount of superelevation is carried around a curve which contains compounds, there is an error of elevation through each compound section, since superelevation must change with a change of radius. As the curve must begin and end in the same tangents, there cannot be a *single* compound in a stringlined curve. A compound in one place calls for a corresponding compound in another place.

Grade Stakes

The superelevation of curves should be established by means of grade stakes set on the inside of the curve opposite each center stake, by accurate level work, and the top of the stake should determine the level of the low rail of the curve. This permits the low rail to be raised to the correct height by the use of the track level from the grade stake to the rail and enables the track men, by use of the track level, to raise the outside rail to the correct elevation for the station involved. To insure accurate elevation, it is advisable to have the amount of the difference in height between rails marked at each station in the spirals and at convenient points through the central curve. Such marking can be provided by painting on the rail or the tie, or a metal tag properly marked may be nailed to the tie. It is not a good plan to have the elevation marks stamped into a rail, for rails may be moved to different locations, and after removal, the markings, which are difficult to erase, may be incorrect for the new location. Furthermore, any information painted on a rail is likely to be obliterated

A Well-Maintained Curve on the Bessemer & Lake Erie North of McBride, Pennsylvania

when the rail is oiled to prevent rust.

Some roads have followed the practice of setting grade stakes in such a manner as to carry the elevation for the center of the track and then depress the inside rail of the curve one-half and elevate the outside rail one-half of the required elevation. This is less suitable than carrying the low rail at the grade line height, because it is more difficult for the track foreman to sight the rail properly and it sometimes gives the appearance of a low spot in the track, thus causing a less-experienced man to alter the elevation by raising what he may think is a low spot.

Curves on High-Speed Track Should Be Maintained With Ties of the Same Hardness and Elasticity

To prevent too much of the train load from being carried by the low rail on curves, some maintenance of way men advocate that there should be a difference of not more than 15 miles an hour in the speed allowed between the fastest and the slowest trains. This plan would depend largely upon how many, and what degree of curves are to be contended with. On most of the railways which are operating present-day high-speed trains, there are some stretches of track where for many miles scheduled speeds of 80 to 100 m.p.h. must be maintained to make up for the much slower speed which is all that it is possible to make through the sharp curves in mountainous districts or broken country. In easier localities, therefore, fast passenger trains run around curves of 1 deg. 30 min. to 2 deg. at speeds which no freight train should attempt to duplicate within 15 m.p.h.

Surfacing of Track

Owing to the fact that the load carried by each pair of wheels in a train is divided unequally when passing around a curve, except when the speed of the train exactly fits the elevation of the curve, it is very important that the track be kept in as near perfect surface as possible. Failure to do so results in an excessive load being placed on one rail, which tends to lower it, thus altering both the surface and the elevation and, usually, a case of bad line develops, with all of these elements helping to cause rough-riding track. To obtain the best riding conditions possible, it is necessary to have uniform elevation and perfect line throughout the body of the curve, and particular attention must be given to the approach and run-off of curves to insure that both the elevation and line increase or decrease with absolute regularity. In other words, at every point on the spiral of the curve there must be the same relation of alinement to elevation as exists on the body of the curve.

Even if the line of track on a curve is perfect, a point at which the gage is wide is apt to cause unsteady travel of the trucks since one pair of wheels of a truck may shift to the opposite side from that which the opposite pair is following, thus giving the car a side lurch with probable recoil, and producing a nosing of the truck. Poor gage is also one of the factors which is sure to be developed further by the increased centrifugal force resulting from high speed.

Ties and Ballast

Owing to the greater impact on the track as a result of high speed, ties cannot be depended upon for so long a service life as they are able to develop under less severe traffic conditions. Both decay and flexibility of the ties are factors in the necessity for their renewal. To transmit the greater load to the ballast, the ties must be placed and maintained with more accurate spacing than formerly and it becomes much more important that ties of the same degree of hardness and of elasticity be used uniformly.

It is highly important that the ballast on curves in high-speed track have a wider and stronger shoulder on the outside of the curve than is required on straight track. This is necessary because of the outward thrust of the trains, resulting from centrifugal force when rounding the curve. The centrifugal force, like the kinetic energy of the train, increases proportionally to the square of the velocity; therefore the ballast shoulder should be built and maintained heavier on the outside.

Drainage

Perhaps no feature of the maintenance of tracks on curves is more difficult than that of drainage, especially if two or more tracks are involved. If the roadbed for all tracks is made level throughout, cross drainage should be provided, and if it is sloped to one side, a line of drain pipe with suitable outlets should be placed between each track and the next lower one, or the water falling upon each track will be drained onto the one next lower, thus creating an excessive amount of moisture to be taken care of by the lower track. It is important that each track be built and provided with drain pipe in such manner that each will take care of its own drainage.

Where a highway grade crossing occurs in a curve having multiple tracks, the original construction of the roadbed should be such as to permit the carrying of as straight an incline of the highway across all tracks as is possible, and the maintenance problem is one of keeping the entire crossing in that condition.

Rails

Perhaps the most critical factor in track for high-speed trains is the rails which must take the terrific impact of the wheels without bending or breaking. Records have shown a very large increase in the number of rail failures within the period since high speed has become a reality. Also we hear from many sources complaints of kinked and bent rails. So great has the kinking and bending become that machines are being offered for the straightening of such rails without removing them from track.

These conditions call for the maintenance of rails with great care and for frequent and careful inspection, not only to discover approaching failures, but rails should be examined under the head and in the upper part of the web for over-stressed conditions which are indicated by the cracking of the scale in a manner similar to that found where rails show bad kinks. This over-stressed

condition may not develop into a broken rail but it is quite sure, if neglected, to develop into a kinked and bent rail which cannot be kept in good riding condition. Where overstressed rails are found, the speed limits should be lowered. There is considerable risk that within a few years we will find that the high-speed steam locomotives have ruined a large amount of expensive rail by bending it long before it is worn out.

Because minor irregularities cause bad riding conditions around curves at high-operating speeds, and also because these irregularities are quickly transmitted to other parts of the curve, it has been necessary with the advent of higher train speeds to educate the average track man to correct those irregularities in line, superelevation and gage which heretofore were of little consequence when train speeds were only 40 to 50 miles an hour.

Everything possible must be done to keep the track structure in as nearly perfect condition as possible. Sufficient anchors must be provided to prevent rail creepage. When track is disturbed, by either raising or lining, the necessary precautions must be taken to know that all ties are well tamped inside and out. Furthermore, the full ballast section should be restored to insure sufficient lateral resistance to the track under traffic. For the same reason tie cribs should be kept filled at all times.

Tie plates should be kept fastened securely to the ties, because the slightest movement of the plates on the ties will result very quickly in irregular gage if it is not taken care of promptly. Track bolts must be kept as tight as possible without causing joints to freeze. It is important that joints be kept free to permit rails to expand and contract. During extremely hot weather, greater care must be exercised in surfacing track or otherwise loosening it in the ballast, because of the possibility of sun kinks occurring by reason of the greater forces acting on it.

Based upon the experience so far gained with the high-speed trains of the present era, it is the conclusion of the committee that much greater care must be given every detail of track maintenance and particularly to the maintenance of accurately lined curves, with properly designed and located spirals, to ease the shock which results both by reason of the change of direction, and of the superelevation of the track to avoid swaying and tipping the cars too rapidly.

Frequent and close inspection must be made of the top, sides, and undersides of the head of rails and the fillets and sides of the web, not only to find incipient cracks and the beginning of failures, but also to detect overstresses, which indicate the beginning of bends or kinks. Where overstress indications are found, the speed of steam locomotives should be reduced or the resulting bent rails will make the maintenance of smooth riding track an impossibility.

Committee—C. W. Baldridge (chairman), asst. engr., A. T. & S. F., Chicago; P. J. Weiland (vice-chairman), roadmaster, C. M. St. P. & P., Ottumwa, Ia.; A. W. Applequist, roadmaster, Soo Line, Bismarck, N.D.; E. L. Banion, roadmaster, A. T. & S. F., Marceline, Mo.; M. R. Black, supervisor, L. & N., Etowah, Tenn.; R. W. Bonney, roadmaster, S.A.L., Lake City, Fla.; W. E. Chapman, supervisor, C. of Ga., Columbus, Ga.; R. L. Fox, roadmaster, Southern, Alexandria, Va.; J. G. Gilley, supervisor, C. & O., Shelby, Ky.; C. J. Jaeschke, division engineer, M.P., Little Rock, Ark.; J. H. Morgan, engineer maintenance of way, F.E.C., St. Augustine, Fla.; S. Payson, roadmaster, St. L.-S. F., Enid, Okla.; J. C. Runyon, supervisor, C. & O., Covington, Ky.; C. W. Russell, roadmaster, Southern, Greenville, S.C.; C. R. Schoenfield, roadmaster, C. B. & Q., Aurora, Ill.; T. N. Turner, roadmaster, M.P., Newport, Ark.; V. R. Walling, engineer m. of w., C. & W. I., Chicago.

Discussion

A. Chinn (Alton) opened the discussion of the report by taking exception to that part dealing with the stringlining of curves, stating that stringlining has gained wide acceptance on many roads. He mentioned 248 curves that had been relined satisfactorily by stringlining on the Alton, and said that as great accuracy of alinement is obtainable by this method as with the transit. He added that the secret of accuracy in either method is accurate measurements and correct calculations. Commenting on that part of the report which pointed out that the stringlining method introduces slight compounds in the curvature by adjusting the mid-ordinates of the proposed curve, he admitted that slight compounds are a necessary part of the calculations, but contended that this is an advantage of the stringlining method; that such compounds are so slight that they have no appreciable effect upon the riding qualities of the curve, and that they permit adjustment of the curve to best fit the existing track, providing a good curve with minimum lining. He added that the lining of many curves by the transit method requires elaborate calculations and takes considerable time.

Referring to the part of the report that stated, "the roadmasters and track men have enough work of their own to do," Mr. Chinn said that while many track men and roadmasters are proficient at stringlining, it is a method that can be used by the engineers as well. He added that roadmasters should be required to know and to apply the stringlining method.

"Contrary to popular belief," he said, "the transit method is not absolutely accurate." A maximum variation in mid-ordinates of 1/8 or 1/10 in. in stringlining, he thought, compares favorably with the probable inaccuracies in stakes set by the transit method. He also claimed that with the stringlining method, it was easy to obtain exactly the kind of spiral desired, and as uniform a curve throughout, as desired, depending upon the accuracy of the measurements taken.

G. L. Sitton (Sou.) stated that he is also a strong advocate of lining track by the stringlining method and that very satisfactory results have been obtained by this method on the Southern in lining curves for train speeds as high as 85 m.p.h. He admitted that many supervisors and roadmasters have used more or less inaccurate and inefficient forms of stringlining in the past, but said that in recent years accuracy and efficiency have been made possible by improved methods, such as the Bartlett method. He said that this method was simple, accurate, easily mastered, fast and economical, and that practically all supervisors on the Southern now use it. In referring to that part of the report which mentioned "fudging the line," he stated that this was a common practice and that it can be done as easily with a transit as in stringlining. He agreed with Mr. Chinn that the small compounds allowed in stringlined curves do not affect the riding qualities of the curves.

W. L. Johnston (Sou.), speaking for R. L. Fox, a member of the committee, stated that Mr. Fox wished to add a recommendation to the report to the effect that he favored the use of stringlining before and after surfacing out-of-face with power tools, and added that usually the same stakes can be used again in lining the curve after it has been surfaced.

J. T. Cothran (Sou.) reported that the average railroad man does not appreciate how practical stringlining is, and especially the Bartlett method, until he has become proficient in its use. He also stated that using the transit method the curve must be lined by eye between stakes set at 50-ft. intervals, with the possibility of some error, which he thought was another factor favoring the choice of the stringlining method.

J. B. Kelly (Soo Line) commented that curves involving compounds were very hard to reline by the transit method, involving many calculations and

much time, but that staking such curves by the stringline method was simple and readily adapted to any condition. He stated that many roadmasters are becoming masters of stringlining, and, in many cases, section foremen also.

M. B. Allan (Nickel Plate) said that he had found the transit method too slow. He stated that on the Nickel Plate, in addition to the routine checking of calculations to insure accuracy, they convert the measured mid-ordinates into degrees of central angle and total them to determine the intersection angle of the curve, and said that the results check very closely with the previously recorded angles. He stated that methods can be used in stringlining to obtain an accuracy of alignment within limits of 1/16 in. He said that if stakes set by the transit method could vary by 3/8 in., as was suggested by Mr. Chinn, a total net error of 3/4 in. could result between two adjacent stakes. Concerning the speed of stringlining, he stated that at one time he staked four curves in four hours, each curve being approximately 800 ft. long, and added that he did not believe such speed possible when employing the transit method.

Chairman Baldridge defended the report criticizing the stringlining method and insisted that the adjustment of mid-ordinates in calculating the curve by this method invariably placed a sharp place in one part of the curve and a flat place in another. He added that he did not believe stringlining was faster or more accurate than transit lining, but said that stringlining could be improved by first locating the P.S. (point of spiral) and S.C. (spiral curve) on each end of a curve as accurately as possible, and then measuring the mid-ordinates of the curve with a length of string which would provide an even number of equal-length middle ordinates on the body of the curve.

Mr. Chinn stated that on the Alton they used a graph of the measured mid-ordinates, and that by selecting the center of gravity of the graph, a mid-ordinate was selected which eliminated much of the necessary juggling and compounding in calculating a curve by the stringline method.

Mr. Baldridge, in further defending his criticism of the stringlining method, stated that the Santa Fe had made a check of stringlining and transit lining by comparing the work of two trained parties, and that the results showed that transit lining was faster and more efficient. In this regard, Mr. Chinn suggested that it was possible that the underlying reason for the unfavorable report on stringlining mentioned might have been prejudice on the part of the engineers in favor of the transit method.

W. O'Brien (Pere Marquette) said that roadmasters could not afford to wait two or three months for engineers to come from division offices and stake curves by the transit method, and that he is teaching foremen to maintain curves by the stringlining method for speeds of 80 to 85 m.p.h.

W. Shea (C. M. St. P. & P.) said that he had first seen stringlining on the Milwaukee in 1886, and that it is being used by engineers today on his road. However, he said that he favored the transit method.

In view of the preponderance of opinion expressed by those present in favor of the use of stringlining, Mr. Chinn offered a motion that the report be amended by a suitable sentence expressing disagreement with that part of the report adverse to the use of the stringlining method. This motion was passed.

Utilization of Roadway Machines

Report of Committee

H. E. Kirby
Chairman

THE utilization of roadway machines is of greater importance today than at any previous time in the evolution through which we have been passing in railroad maintenance practices. This evolution represents changes that have been made voluntarily by the railroads, or which the roads have been forced to make as a result of the increased demands of new conditions, usually in the form of higher speeds and heavier wheel loads. In turn, these changes have required heavier rail sections, a general improvement in the standards of track construction, and more exact line, surface and drainage conditions.

During the time when many of these new conditions were being brought about, the railroads were also confronted with a period of stringent, forced economy. Thus the problem of using machines in maintenance of way work to effect economies required intensive thought by maintenance men, and at the same time enlarged the field for roadway equipment. The makers of maintenance machines met this situation, so far as they were concerned, with the result that labor-saving machinery has been developed to the point where we now have specialized equipment for many kinds of maintenance jobs. The extent to which mechanical power has been adopted will be seen from the fact that American railroads have invested more than $100,000,000 in such specialized maintenance equipment.

The responsibility for obtaining a fair return on the money the railroads have invested in these machines should be kept constantly in mind, and should receive particular consideration from those officers under whose direction work is programmed and performed. Each machine represents a definite cash outlay, and will last only a given number of years. Thus each unit should be considered as having been hired under contract for that term at a fixed salary per year, regardless of how much or how little it is worked. A machine, in contrast to a workman, cannot be furloughed. Once it is purchased the costs of the investment go on day after day, and the only way to overcome these costs is to work the machine. Hence, those who are given the job of organizing gangs to use mechanical equipment should remember that one of the important principles in the design of a gang is to secure maximum use of the equipment. Interest costs can be figured readily. Depreciation calculations are usually less exact, because machines generally become obsolete before they are worn out, and the rate

of obsolescence is not so much a factor of time as of new developments. It is probable that, at the present rate at which new and improved equipment is being brought out, a depreciation period of more than ten years is excessive. On this basis, the accompanying example of investment costs is given for one class of power equipment (pneumatic tie tampers).

A study of replies to a questionnaire which your committee addressed to representative railroads indicates that we are not making full use of many of our roadway machines. The average service per year for several kinds is reported as follows:

Roadway machines	Average days service per year
Rail cranes	128
Mechanical wrenches	200
Mechanical spike pullers	71
Mechanical spike drivers	71
Mechanical adzers	88
Pneumatic tie tampers	118
Electric tie tampers	118
Self-contained gasoline tie tampers	118
Arc welders	208
Crawler tractors, bulldozer	92
Tractor excavators	76
Rail grinders, surface	208
Rail grinders, cross	168
Rail drills	54
Weed mowers	83
Ditchers	132
Spreaders	80
Saws, timber	60
Saws, rail	21
Ballast cleaners	170

It follows from the above considerations that the more use that is made of a machine the greater the return on the investment in it. First responsibility in this regard lies with those who program the year's work. They should coordinate, so far as possible, all maintenance jobs with the view of providing maximum use for every piece of equipment. At best, however, unavoidable limits are imposed by certain seasonal work and by some specialized or single-purpose machines. In an effort to overcome these conditions and to provide additional uses for roadway equipment, a few roads, according to reports, have adopted a plan whereby equipment is first used on scheduled maintenance work, after which other departments are given an opportunity to use it for any work for which it is adapted. In this connection, the Committee on Maintenance of Way Work Equipment of the American Railway Engineering Association studied this matter and reported* in part as follows:

"The use of these machines is not confined to maintenance of way work, and to keep the machines busy throughout the year, and thereby affect maximum savings, departmental lines must be erased and the system officer in charge of the work equipment should work in close touch with the mechanical and other branches of the service, they keeping him advised as to their needs and he in turn arranging and notifying them when they can have the service required. This plan has been partially tried out on at least one railroad and it was found when maintenance machines were not required on maintenance work they have been used to advantage and have been the cause of effecting great savings in the mechanical department.

"We have prepared a list of jobs that can be considered non-seasonal, on which these machines can be used (see Exhibit A). This list is not complete and will vary on the different roads. Some roads may not have all of these jobs, while others will probably have work not shown.

"We have prepared (see Exhibit B) a list of machines in most general use on all railroads reporting. The figures in Column 1 indicate the number of days that the different machines must be worked in order to return carrying charges. In other words, they do not become money savers until after working the number of days shown.

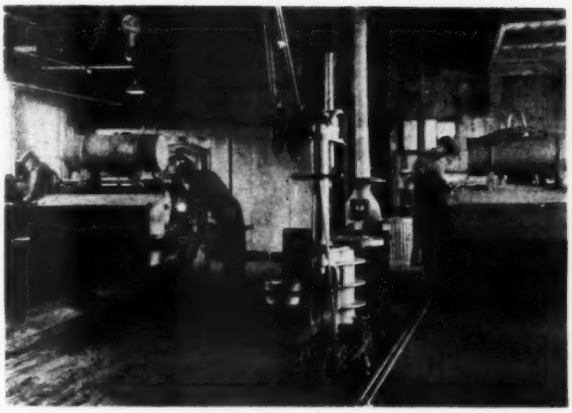
"Column 2 shows the number of days of seasonal maintenance work for the different machines.

"Column 3 shows the number of work days it is possible to expect from each machine.

"Column 4 shows the number of days that the machines are available for other than seasonal maintenance work.

"Column 5 shows by number the non-seasonal or other jobs that can be considered non-seasonal on which machines can be used. (See Exhibit A for details.)

"The difference in the number of days per annum that machines can be used on seasonal work (Column 2, Exhibit B), and the possible number of days that such machines are available (Column 3), which is shown (after deducting the number of days necessary for repairs) in Column 4, indicates the possibilities for greater utilization of equipment, and resulting economies, through scheduling the non-seasonal work."



Maintenance of Way Equipment Should Be Scheduled for Overhauling at Regular Intervals

Investment Costs of Pneumatic Tie Tampers

	Size of Equipment			
	8-tool	12-tool	20-tool	24-tool
Approximate investment:				
Compressors	$3,000	$4,075	$ 7,075	$ 8,150
Tampers	1,125	1,625	2,750	3,250
Pipe and hose line	750	925	1,700	1,850
Total investment	$4,875	$6,625	$11,525	$13,250
Annual charges:				
Interest at 6 per cent	$ 292	$ 398	$ 692	$ 795
Depreciation—annuity at 6 per cent for ten years	369	503	875	1,006
Total annual charge	$ 661	$ 901	$ 1,567	$ 1,801
Daily cost of investment:				
Working 300 days per year	$2.20	$3.00	$ 5.22	$ 6.00
Working 200 days per year	3.30	4.50	7.84	9.00
Working 100 days per year	6.61	9.01	15.67	18.01

System Equipment

The value of intelligent programming and scheduling of the work for machines cannot be overemphasized. Likewise, the purchase of such equipment should be made with a system

*Proceedings, volume 32, page 455.

perspective; that is, from the point of view of the entire property and not influenced by unusual conditions on one or two divisions or solely heavy-traffic territories. Weighing and evaluating the requirements of all subdivisions will prove economical in reducing the investment in or the first cost of the equipment. It may be economical to duplicate tamping equipment, for example, on several divisions of a road because of climatic conditions (length of season during which track can be worked), the desirability of prompt surfacing of track on which new rail has been laid, and for other reasons, while other roads can undoubtedly effect savings by investing only in enough machinery to equip one or more large system ballasting gangs.

The case of rail-laying equipment is somewhat different, since for roads having average conditions of traffic, annual rail renewals, length of time the track may be closed to trains, wage scales and number of tracks, definite economy results from the use of a completely mechanized gang of about 94 men, not including those men employed with work trains unloading and loading rail and fastenings, and the preliminary distribution of other materials. However, certain reports indicate cases in which rail is laid economically by small gangs with little or no power equipment, while others indicate preference for a larger, partly mechanized gang.

It will be seen, then, that at this stage of development, economy will result from the use of system rail laying gangs, and that the investment in power machinery to equip several division rail gangs cannot be justified except perhaps in the case of a railroad with a large rail program, being required by its management to lay all of the rail in a very limited time. Along with many other advantages, system forces are naturally more efficient, owing to the specialization of work which requires no change in basic consist of the gang, and in which each man does the same job every day in his unit of the organization as a whole.

When the system gang moves from division to division, there is not the usual time wasted in breaking in new men, and in "getting organized." Its equipment is ready; the gang supervision is the same; every man knows his job and begins it at once. In every case, at least limited centralized control should be exercised over gangs, and it is no less important where the larger, specially-organized gangs are used for laying rail, that a roadway or track engineer keep in close touch with them to see that equipment is being used properly and is kept in good operating condition, and that co-ordination between all of the units of the organization is maintained to obtain maximum efficiency.

Aside from the economy resulting from the planned use of practically all types of power equipment, other

EXHIBIT A

Job No.	Class or Kind of Work
(1)	Breaking concrete or stone
(2)	Cleaning open wells
(3)	Cleaning hot wells
(4)	Coaling engines while chutes are being overhauled
(5)	Cleaning and painting
(6)	Clearing main and yard tracks of snow and ice
(7)	Cutting ice at track pans
(8)	Dismantling retired rolling stock and buildings
(9)	Digging open wells
(10)	Disposing of rubbish at terminals
(11)	Disinfecting boarding houses, bunk cars and stock yards
(12)	Drilling holes in ties for spikes or lag screws
(13)	Excavating scale and turntable pits, etc.
(14)	Erection of structural buildings
(15)	Electric lighting for tunnels and night work
(16)	Freight car construction and heavy repairs
(17)	Handling rail
(18)	Handling scrap
(19)	Placing drain or culvert pipe
(20)	Placing and removing screw spikes and lag screws
(21)	Running up and running off track bolts
(22)	Replacing gantry or overhead cranes needing repairs
(23)	Renewing decks on pile trestles
(24)	Special work around shops, stores and roundhouses
(25)	Spike driving
(26)	Setting pre-cast foundations, signals and battery wells
(27)	Transferring or shifting "Bad Order" loads
(28)	Whitewashing

EXHIBIT B

Kind of Machine	(1) No. days per Annum machine must work to return carrying charges.	(2) No. days seasonal maintenance of way work per Annum on which machines can be used.	(3) Possible No. days per Annum for each machine.	(4) No. days available for non-seasonal work.	(5) Work that can be considered non-seasonal.
Steam ditcher	21	244	*335	91	1-2-3-4-9-13-14-17-19-26.
Ballast discer	8	183	183	....	.....
Bonding drill	9	365	365	....	.....
¾-yd. steam or gas shovel caterpillar (x)	23	244	*335	91	**1-2-3-4-14-17-19-22-24-26
Madden rail layer	10	365	365	....	.....
Track mower	8	153	153	....	.....
Oil spray	23	122	365	241	5 and 28
Portable electric rail saw	100	365	365	....	.....
Rail loader—air	10	365	365	....	.....
Rail laying crane	30	365	*335	....	19 and 23
Tie tamper (air—old 4-tool)	35	244	*335	91	1-5-7-11-12-14-20-21-23-25-28
Tie tamper (air—8 and 12-tool)	30	244	*335	91	1-5-7-11-12-14-20-21-23-25-28
Tie tamper (electric)	30	244	*335	91	7-12-15-20-21-23
Weed burner	30	183	*335	152	6
Power track drill	30	365	365	....	.....
Tie adzing machines	30	365	365	....	.....
Paint spray	40	365	365	....	11 and 28
Locomotive crane (x)	25	244	*335	91	1-2-3-4-8-9-10-13-14-16-17-18 19-22-24-26-27
Pneumatic spike driver	10	308	365	....	1 and 7
Pneumatic bolt wrench	13	308	365	....	12 and 23
Electric bolt wrench	13	308	365	....	12 and 23
Track raising and shifting mch.	37	183	*335	....	.....
Ditcher-spreader	15	244	*335	91	6 and 10
Track ballaster	20	180	250	....	.....

*It is estimated that larger machines to which all repairs cannot be made in the field will be out of service an average of 30 days each year for repairs.

**Machine equipped with crane boom will handle these jobs.

xMachines to be equipped with clamshell and dragline bucket, hook block and magnet to enable it to do the various jobs.

important advantages to be found in the use of machinery are improved quality of the work and, in general, improved safety records. Both of these represent cash savings. The margin of the saving over hand methods produced by the use of certain units of equipment may be very narrow, but the quality and uniformity of the finished job may more than justify their use. It is known definitely that rail laid on mechanically-adzed ties produces smoother and better riding track. This must be said also for power-tamped track, which, it has been proved, stands up longer between surfacings than when hand tamped, and with less damage to the ties. Likewise, track bolts tightened by mechanical wrenches, set to release at a predetermined point, are assured of fairly uniform tension throughout the rail joint.

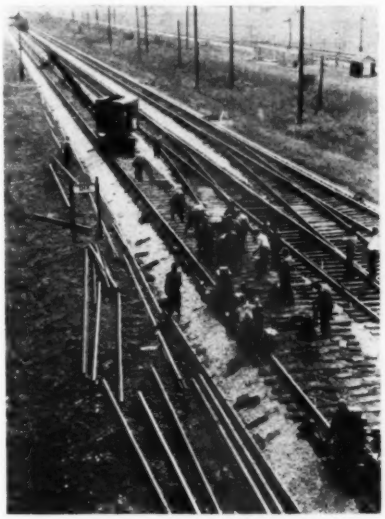
In the complete report on "The Use of Work Equipment to Secure the Greatest Economy in Track Maintenance," which was prepared in 1936 by a committee of the association, of which R. W. Grigg was chairman, many cost and production figures were given. Also, discussed at length, was the application of a number of maintenance machines. After reviewing previous reports and answers to a questionnaire sent out during the present year, this committee believes that developments during the last two or three years are not of sufficient importance to justify an attempt to enlarge upon or to improve the figures given previously.

Off-Track Equipment

The use of several types of off-track machines is proving to be economical practice, particularly in dense traffic territories. This may be said also of the use of highway trucks and automobiles in congested territories where highways are convenient. One New England railway is said to own 142 such vehicles, 128 of which are used exclusively by the maintenance of way department. This subject is described at length in a report of the American Railway Engineering Association, appearing in Proceedings of that association, Volume 40, page 316.

Any discussion of the utilization of roadway machines must include consideration of methods of repairing and overhauling, and of the selection of such machines and the training of maintainers and operators. Obviously, a machine cannot be used if it is not kept in good operating condition. We have seen how investment costs vary inversely with use. It is reasonable to expect upkeep costs to vary directly; the more a machine is used, the greater the wear and tear. Hence, the importance of systematic repair methods and adequate supervision. A study of this phase of the subject by a subcommittee of the American Railway Engineering Association, of which C. H. R. Howe was chairman, included the following statement*:

"We may assume that railroads in general have provided supervision and have established means for taking care



Rail Laying On Many Railroads Has Become a Highly-Mechanized Operation, Using Many Types of Equipment

of general overhauling. The problem then becomes one of keeping down the cost of depreciation and running repairs through proper care and operation of the equipment. As this is a matter largely in the hands of the operators of the various machines, study of this feature is considered the essential subject of the committee's assignment."

That study also produced the conclusion:

"The extent of the railways' investment in roadway work equipment requires the establishment of systematic methods of protecting that investment, to secure the maximum return on the money involved.

"To obtain this result it is our recommendation:

(1) That proper care be given to the selection of prospective operators.

(2) That the appointment of an operator should be preceded by placing him with an experienced operator for a period of training. During the training period he should familiarize himself with that portion of the Manual of Instructions that pertains to the particular machine until his qualifications are proved by means of an examination by the maintainer.

(3) That division and other officers directly responsible for the use of work equipment thoroughly familiarize themselves with the contents of the Manual of Instructions in order that they may properly supervise compliance with the rules."

*Proceedings, Volume 37, page 170.

Perhaps the best method of maintaining equipment is to schedule general overhauling at regular periods and to keep running repairs at a minimum. It is necessary, then, that proper care be taken of machinery, both when in use and while idle. It should be emphasized that repairs caused by neglect and misuse are not only costly in themselves, but that breakdowns from any source while work is under way will result in expensive delays by disrupting a well-organized gang. As an example of possible loss, suppose the breakdown of a single machine delays a mechanized gang of 100 men for half an hour. The loss from unproductive labor alone, in this case, will amount to approximately $22.

Operators and Maintainers

In general, the scarcity of employment during these times will permit greater care in the selection of operators and maintainers. For several reasons it is important that the proper choice be made in the beginning, among these being the fact that in some cases craft agreements may make it impossible or difficult to readjust matters at a later date.

The primary qualifications for these positions, aside from those mental, moral and physical qualities essential in all employees, are a natural aptitude for machinery, and care and orderliness about mechanical equipment. The first of these is practically a necessity. Orderliness may be taken as an indication of the type of service that can be expected from a man and the equipment in his charge. Maintainers are often selected from the ranks of operators, and in general owe their promotion to possession of these qualifications.

The first objective is to establish over the system a plan in which uniform operating practices are in effect for all types of roadway machines, and under which the uniform handling of repairs and care of equipment are assured. To do this it is necessary first to set up rules of standard practice, and then to provide adequate supervision to see that instructions are followed over the system.

Summary

In the foregoing discussion we have held to a somewhat strict interpretation of the assignment. Attempts to branch out and enlarge upon several interesting phases coming under ob-

servation were considered to be impracticable owing to lack of reliable information. From this study the following points are offered in summary:

(1) To keep the cost of owning roadway machines at a minimum, as much use as possible should be made of every machine.

(2) The use of power equipment in most cases produces economy over hand methods. The flexibility of certain units of equipment prevents losses that would otherwise be incurred.

(3) The maintenance work performed by machines is equal or superior to that done by hand. Machine work is definitely more uniform, smoother, and stands up longer.

(4) The purchase of equipment should be made from the point of view of the system, and transfers and assignments handled from a central office. General overhauling and running repairs should follow a systematized practice. In general, the use of power-equipped system track gangs is more economical and more efficient than duplicate division gangs.

(5) Particular care should be exercised in selecting men for the positions of operators and maintainers of roadway machines.

Committee—H. E. Kirby (chairman), asst. engr., C. & O., Richmond, Va.; R. S. Kniffen (vice-chairman), gen. rdm., G. N., Duluth, Minn.; G. W. Benserf, supv., C. of Ga., Griffin, Ga.; M. D. Carothers, div. engr., Alton, Bloomington, Ill.; R. H. Gilkey, div. engr., C. of Ga., Savannah, Ga.; R. E. Meyer, rdm., C. & N. W., Mason City, Ia.; M. R. Palmer, rdm., A. T. & S. F., Las Vegas, N.M.; E. L. Potarf, asst. supt., C. B. & Q., Sterling, Colo.; W. G. Radford, supv., Sou., Greenville, S.C.; J. T. Stotler, rdm., N.P., Lester, Wash.

Anchoring Track to Meet Present-Day Conditions

Report of Committee

THE problem of anchoring track is not new. It is a problem which the roadmaster has had to face almost since the beginning of the movement of self-propelled vehicles over metal rails. However, it is a matter on which the man in the field has had to be guided largely by rule-of-thumb methods developed by his experience. There is surprisingly little literature on the subject. While voluminous reports have been made to various railroad associations and maintenance of way clubs on almost every phase of track construction and maintenance, the matter of anchoring track has been little touched on. The A.R.E.A. Manual simply says that "The use of anti-creepers to prevent longitudinal movement of rail in track is recommended."

Two primary factors cause movement of track, making its anchorage necessary. The first is the expansion and contraction of the rail, which takes place with temperature changes. The second is the effect of train movements over the rail. Both of these factors have been present since the beginning of steam railroads. Greater refinements in track maintenance have made the effect of the former more apparent. Higher train speeds and heavier axle loadings have increased the effect of the latter.

However, a new development has focused attention on, and emphasized the importance of adequate track anchorage. This development is the installation of standard rails welded together to form continuous rails up to a mile or more in length. Standard 39-ft. rails are normally laid with allowance for changes of 5/16 in. in length over a temperature range of 100 deg. Obviously, no corresponding provision can be made

J. J. Clutz
Chairman

with a rail a mile long, as a 42-in. opening would be required. The dramatically successful anchoring of such welded rail, and the wide advertising given to track laid with welded rail, have spotlighted track anchorage.

While there are comparatively few installations of such welded rail, and most of us are still working with track laid with rails of standard length, fastened together with bolted joint bars, we are all faced with the problem of maintaining smooth-riding track with reduced maintenance budgets, despite higher train speeds and heavier axle loadings. Every factor entering into track maintenance has to be studied carefully. Such a study reveals the importance of proper track anchorage in relation to the other factors involved in track maintenance, and its effects on them. Proper anchorage, adequately maintained, pays dividends, in reducing other maintenance costs.

Anchorage Is Necessary

No one can question the necessity for anchoring main-track rails. Safety of operation requires it. Without anchorage, the rail will run irregularly, resulting in places where the expansion stresses are concentrated, and where the track may buckle or warp out of line or surface so badly in hot weather that a derailment results. At others, the joints will be open, resulting in a concentration of the contraction stresses in very cold weather which may shear off the joint bolts at one or more joints, leaving the rail ends free.

We are concerned here with the study of track anchorage, not merely for safety of operation, but beyond that, for economical maintenance of the track structure as a whole, in that good-riding condition under high speed operation which the public demands. Inadequate anchorage, resulting from either an insufficient quantity of anchors or improper maintenance, affects general track maintenance directly and heavily. Slued ties result, causing irregular line and tight gage. Anchor ties are moved off their bed, resulting in poor surface. The uniform rail joint openings are destroyed. Some joint openings become too wide, causing excessive batter and breakdown of the joint surface at the rail ends. Others become too tight, resulting in chipping of the rail ends. The tight joints may cock in or out in hot weather, causing irregular gage and line, with consequent poor riding track. If the joint ties are slot spiked, they may

be split and thus rendered valueless.

At turnouts, crossovers, and crossing frogs, movement of the track is especially hazardous. It may distort the entire turnout assembly, throwing it out of line and gage, making the switch difficult to throw and giving a very rough ride. Running of the rails may move interlocked switches so much as to cause switch failures and consequent train detention.

Tight or open track will cause difficulty in carrying on many maintenance operations. It is difficult to renew rails, change insulation, install joint shims, or renew joint bars if the track is not so anchored as to hold its position when one or more joints are opened. No hard-and-fast rules can be laid down for the number of anchors to be used on a given stretch of track. The factors affecting rail movement vary too widely. It is the purpose of this report to study the factors affecting rail movement, the progress to date of the art of anchoring rail, and the best known practices for maintaining rail anchorage, as a guide to the individual in helping him to solve his anchorage problems.

Two Basic Factors

The two basic factors in rail movement are the effects of temperature changes and train movements. While temperature changes are usually uniform over a given section of track, they may be affected by variations in exposure to the sun, caused by cuts, tunnels, woods, buildings, cars stored on a siding adjacent to the main track, etc. The anchorage at each rail to overcome temperature-induced movement should, therefore, be uniform and sufficient to localize the movement to that rail.

The effect of trains on rail movement varies widely. Primarily it is the wave motion set up in the rail and track by the passage of a train, that causes rail movement. This wave motion normally tends to move the rail forward in the direction of the train movement. Superimposed on this, at points where trains accelerate or decelerate, such as stations, water pans, speed restrictions, interlockings, etc., is the push back of the locomotive driving wheels in starting or accelerating the train, and the effect of that portion of the braking action that is not turned into heat, in pushing the rail forward.

The wave motion in the rail is affected by the condition of the subgrade, the tightness of the track, the weight of the rail and fastenings, the kind and depth of ballast, the size and number of the ties, etc. Generally speaking, the stiffer the track structure, the more solid the sub-grade, and the better the ballast is locked together, the less is the wave motion, and the less the track movement.

Other Factors

The effect of temperature changes and train movement in causing rail movement is modified by other factors. Rail naturally tends to move more downhill than up. It tends to move more on curves than on tangent. On single track, or on multiple tracks used in both directions, the tendency is for the rail to move in the direction of the heaviest tonnage.

However, there are individual cases where the movement is opposite that to be expected normally. One road reports rail moving consistently uphill at the bottom of a long grade. One member of the committee had the experience several years ago of laying a long stretch of new rail on a rolling grade, around curves in both directions. Within 24 hours one rail moved about 18 in., against the current of traffic so that the rail anchors either slued the tie behind, or the rails pulled through them until it was necessary to reverse the anchors on this rail. The other rail moved in the normal direction. The rail replaced, which was of a different section from the new rail, had always run in the direction of traffic. After several months in the track, the new rail stopped running backward on the one side, and ran forward. When the track was worked again, several years later, the rail again ran backward for a few months, then resumed its normal forward movement with the traffic. It is such factors as these that make it impossible to lay down hard-and-fast rules for anchoring rail. Instead, the conditions surrounding each case must be studied, and the track anchored and maintained in the light of what is known of the art of anchorage to date.

Well Anchored Track On the Radford Division of the Norfolk & Western

History of Rail Anchorage

In the earliest railroad track, no provision was made for anchoring. Train speeds were not high. Standards of track maintenance were low. Axle loadings were light. All railroads were single track. Braking was primitive. Acceleration and deceleration were low. The public was content merely to travel by railroad and did not demand smooth track or safety. There was then no crying necessity for anchoring the track.

But as train speeds and axle loadings increased, the wave motion set up in the track by the passage of a train became greater, tending to make the rails run under traffic. Safer, smoother-riding track was demanded by the public. Standards of maintenance became higher, while money available for maintenance decreased. The necessity for anchoring then became apparent. When air brakes were developed, permitting rapid braking, the transfer of the kinetic energy of the train to the track structure in a comparatively short distance, with consequent distortion of it, emphasized the importance of adequate track anchorage.

Originally the simplest thing was done to anchor the rail. Spike slots were cut in the base of the joint bars where they projected beyond the rail base, and the rail spikes were driven through the slots. This answered for a time, and is still in use on some light-traffic, slow-speed lines.

However, on heavier-traffic, higher-speed lines, this type of anchorage was insufficient. The joint ties were slued on the spiked end, causing poor line and gage. To overcome this and to provide additional anchorage, slots were cut in the base of the rail center opposite the joint for slot spiking. These slots caused the rail to break. A clip was then developed, bolted to the rail web and extending out over the rail base, with a spike slot in it. Some of these are still in use on light traffic branch lines.

The slot spikes naturally tend to split the ties, and eventually tear them apart under any great amount of traffic. This was not so serious when ties were untreated and in any case failed in a few years through decay. As the use of treated ties became general, with greatly prolonged life through freedom from decay, the

prevention of early mechanical failure of the ties became highly important. Splices were developed with dependent flanges extending down between the joint ties and bearing against their sides. This transferred the stress against the tie instead of into it through the spike. The splitting action of the slot spike was thus eliminated.

However, the joint is acknowledged to be the weakest point of the track structure—the point where surface and line usually break down first. Anchoring the rail at the joint accelerates this breakdown and this practice is now generally recognized as being undesirable.

The Germ of an Idea

The dependent-flange joint bar, bearing against the side of the tie, contained the germ of an idea—that the stress should not be transmitted into the tie by the spike, but against the side of the tie, thus eliminating any tendency to split it. This resulted in the development of the rail anchor, or anti-creeper as we know it, a device which fastens to the base of the rail by a wedging or clamping action, and bears against the side of the tie. There are a wide variety of these anti-creepers on the market, differing somewhat in design and efficiency, but all working on the same principle. They are independent of the other rail fastenings and permit transfer of the rail movement stress to the ties at points other than at the joint, a very desirable feature. This type of anti-creeper has been in use for some years and is generally used by all railroads.

Anchoring Welded Rail

With the development of standard rails welded together to form a continuous rail, up to a mile or more in length, installed in open track, the vastly greater cumulative expansion and contraction temperature stresses had to be taken care of. It was believed that a more positive anchor, acting at all times, was desirable. Various types of fastenings were developed, providing anchorage through the tie plate to the tie. All work on the same principle of bearing against the top of the rail base. Some clamp the rail rigidly to the tie plate with solid clips bolted to the tie plate. Others use spring clips bolted or wedged to the tie plate. Tie plates with integral spring clips have been developed. Special spikes, providing elastic and positive bearing against the rail base are on the market.

There can be no doubt of the success of these various types in providing positive anchorage through the tie plate to the tie since many miles of welded track, installed with them, are in service. However, their first cost and their cost of installation are inevitably higher than for standard rail anchors. While they have not been in service long enough to develop fully their service life in comparison with standard rail anchors, several unexpected features are coming to light. They are expensive to maintain. The wedges get loose, the nuts loosen up, the bolt threads corrode and make tightening difficult, the spring clips break, and derailments, or dragging equipment, play havoc with some types.

They function by anchoring the rail rigidly to the tie through the tie plate. In ordinary track construction, with cut spikes and standard rail anchors, the head of the spike is from ¼ to ½ in. above the top of rail base. This permits the rail to move up and down slightly in the wave motion set up by passing trains without causing the tie itself to move with the positive anchorage through the tie plate to the tie, for the tie itself must follow every move the rail makes. This positive anchorage tends to make the track stiffer, and cut down the severity of the wave motion for individual trains. On light-traffic lines, this apparently results in economy of maintenance. However, on heavy traffic lines, particularly where the speed is high, there are indications that this constant movement of the ties causes line and surface to break down quickly, greatly increasing the expense of maintaining the track in good riding condition.

Some roads have stopped applying the special tie-plate fastenings to every tie and are applying them only to every alternate or every third tie, the standard tie plate and driven spike being used on the intermediate ties. One road has made an installation of welded rail with ordinary rail anchors, with complete success to date. It will be interesting to follow this trend, and note the decision eventually dictated by experience.

However, most of us, with little or no rail welded together in long stretches, continue to use rail anchors. It is with the use of rail anchors in standard type track that we are concerned primarily.

Installing the Anchors

Rail anchors are usually applied originally when the rail is laid. To preserve the temperature expansion opening at each joint, the anchors must be applied to the new rail before any trains pass over it. It is usual to place the smaller end of the anchor on the outside of the rail, with the large end on the gage side where it is less likely to be damaged by wheel flanges in case of a derailment, and where there is less likelihood of a wheel flange driving the anchor down against the rail base and nicking it, which usually results in a broken rail.

The exact number of anchors to be applied must be based on experience with the track at the location in question. The number of anchors used per rail length in open track varies from only joint-slot spikes on light-traffic, slow-speed branches, to 24 anchors per rail length of track on heavy-traffic main lines, with extra anchors up to the maximum number possible, that is, one on each rail against every tie, for several rail lengths approaching draw bridges, interlocked switches or other critical points where trains normally slow down.

The anchors are usually distributed uniformly through the rail panel, and are applied to the rail at opposite ends of the same ties to minimize tie sluing. This uniform distribution is based on the theory that, with the tie cribs filled with ballast, the pressure of the anchors against one tie will be transmitted through the ballast to several ties in front, thus increasing the resistance of the rail to movement; whereas, if the anchors were applied to several adjacent ties, under heavy stress, they would tend to move as a unit, as the stress would then be concentrated.

However, some roads are experimenting with other than such uniform distribution. One road applies all the anchors at the end of the rail, on the theory that they will thus better resist movement from the wave motion set up by trains and permit any movement due to temperature changes to take place at the rear end of the rail. Another road bunches all the anchors at the middle of the rail on the theory that temperature changes in rail length can take place either way from the middle.

Anchors should be applied against sound ties, preferably those having vertical sides, to afford good bearing for the contact face of the anchor against the tie. They should be applied snugly against the tie face so that they will not have to be driven along the rail base to bring them into contact with the tie. Driving the anchor along the rail base tends to spring it and destroy its holding power. It is much better to remove the anchor and reapply it snugly against the tie face. If it is known that the rail will have a tendency to run backwards for a time, as is frequently the

case, sufficient reverse anchors should also be applied to counteract the tendency of this reverse movement.

How to Maintain Anchors

Obviously, a rail anchor not in contact with the tie performs no function and, therefore, is of no value. They must be maintained in constant contact with the ties. When any work is done, such as renewing or spacing ties, cutting in longer or shorter rails to restore correct joint expansion openings, etc., the rail anchors affected should be removed and reapplied snugly against the ties and never driven along the base of the rail. Rail anchors which have ceased to function as such, as a result of springing, breakage of parts, corrosion, etc., should be replaced promptly. All too frequently missing or loose anchors are not replaced promptly, with the result that the remaining anchors are unable to restrain the rail movement.

Every foreman should have a small working supply of anchors, just as he has of bolts and spikes, so that he can keep his track fully anchored. If special tools are required to apply the type of anchor that is furnished him, he should have such tools. Frequently, foremen do not keep all their anchors up against the ties and are unable to reapply them when removed in connection with other work, because they do not have the necessary special tools. For this reason it is generally better to use anchors which can be applied with the standard maintenance tools which every section and extra gang has for its regular work, such as the spike maul or the eight-pound sledge.

While a tie, newly installed or shifted to a new position in spacing, will not at once offer as much resistance to rail movement through an anchor against it, as a tie that has remained undisturbed on its original bed, it is generally agreed that it is better to retain the anchors in their original positions on the rail, rather than to shift them to bear against undisturbed ties. If the new tie has been tamped thoroughly and the cribs have been well filled with ballast, so that the adjacent ties will help to resist the thrust, the new tie will be able to hold its position against the anchor with very little movement before it becomes finally seated. If the track is to be given a lift so that all ties will have a new bearing on their beds, and most tie installations are now made in main track in connection with giving the track a light lift, it would appear desirable to replace the rail anchors in their original relative position against new ties. These will be less subject to cutting by the anti-creepers than the older ties; they will remain in the track longer, thus affording more permanent resistance for the anchor than the older ties and will offer practically the same resistance to movement as the older ties, particularly if they have been well tamped, so that the ballast bites into the bottom of the tie.

Other Factors

The use of double-shoulder tie plates is becoming quite general. Where they fit snugly against the rail base and are equipped with plate anchor spikes, they tend to lock the rail base and offer very considerable resistance to rail movement. They also contribute greatly to the general stiffening of the track structure. Where they are applied out of face, experience to date indicates that a 25 per cent reduction in rail anchors can be made, compared with similar track laid with single shoulder tie plates.

The ballast is very important in the anchoring of track, as it is the medium through which the stress is carried from the tie to the sub-grade. Rail anchors are of themselves of no value if there is not enough ballast of the right kind to hold the ties in position by resisting the stress arising from the anchors. The tie cribs should be well filled and there should be an adequate shoulder or depth of ballast in the intertrack space.

Generally speaking, the track-anchoring value of ballast corresponds to its value in maintaining line and surface. Crushed trap rock is the best and dirt is the poorest. The scale extends downward from crushed trap rock through limestone, slag, gravel, cinders and chatts, to dirt.

Obviously, there is no point in providing extra rail anchors at critical locations if the ballast will not transmit the stresses properly to the sub-grade. As a result, it is not uncommon to have stone ballast applied through and approaching remote-control switches on branches that are otherwise ballasted with cinders or gravel, to obtain the greater holding power of the crushed rock where the greater anchorage resistance is needed.

Maintenance of the joints in such condition that the normal expansion and contraction of the rail can take place is very important. If the joints are frozen so that the rail, in expanding, cannot close up the joint opening, it will naturally move as a unit back to a point where there is an unfrozen joint. This will move the anchor on the rails involved back from the ties against which they normally bear and will concentrate so much stress in the leading rail of the stretch having frozen joints that anchor ties will probably be slued, affecting surface, line, and gage unfavorably.

Conclusion

Since no exact rules can be laid down for the number of anchors to be applied to any particular track, and since proper anchorage is important not only to maintain the track in safe condition, but pays large dividends in reducing the cost of maintenance of the track structure as a whole, it is urged that every track supervisor and roadmaster not only study conditions on his territory to insure that he obtains adequate anchorage of the track structure without installing an excess number of anchors, but that he also acquaint his foremen with the factors affecting track anchorage and that he emphasize to them the savings to be realized through adequate anchorage, properly maintained.

Special Conditions, Such as Road Crossings and Through Station Grounds, Often Require Unusually Heavy Anchorage

Committee—J. J. Clutz (chairman), acting asst. div. engr., Penna., Jersey City, N.J.; R. L. Longshore (vice-chairman), gen. main. insp., Wabash, St. Louis, Mo.; R. F. D. Bowman, rdm., C. P. Lethbridge, Alta.; A. B. Chaney, dist. engr., M.P., Little Rock, Ark.; H. E. Durham, rdm., K.C.S., Pittsburg, Kan.; F. L. Etchison, rdm., A.C.L., Charleston, S.C.; S. J. Hale, asst. supt.,

N. & W., Bluefield, W. Va.; L. W. Jones, rdm., C. B. & Q., Curtis, Neb.; O. I. Miller, rdm., C. M. St. P. & P., Marion, Iowa; C. T. Mulchay, rdm., S.P., Bakersfield, Cal.; W. A. Murray, engr. m.w., N.Y.C., New York; Wm. O'Brien, rdm., P.M., Toledo, Ohio; F. G. Walter, asst. engr., I.C., Chicago; J. F. Barron, asst. rdm., Sou., Hattiesburg, Mississippi.

Discussion

The discussion of this report was confined in the main to a consideration of the phenomenon occurring when the rails creep in opposite directions. A. Chinn (Alton) recited several instances of this nature that have come to his attention, including one case in which one of the rails moved uphill and against the current of traffic, but said that he could offer no logical explanation. A somewhat similar instance, involving 127-lb. rail, was described by L. M. Denney (C. C. C. & St. L.).

P. Chicoine (C. P. R.) said that, when confronted with a case involving rail creepage in opposite directions, he concluded that the trouble was due to the fact that not enough expansion had been allowed in one of the lines of rails. Acting on this theory he took the necessary steps to increase the allowance for expansion, after which no further trouble was experienced. Referring to the fact that rail anchors are often found to have moved some distance away from the ties, Mr. Chicoine stated that his experience had been that this occurs during hot weather and that at night the anchors again move up against the ties. In cases where the rails on curves move in opposite directions, he said the trouble might be attributed to forces set up by the slippage of the wheels of equipment.

W. H. Sparks (C. & O.) said that it has been his observation that it is usually the rail on the fireman's side of the locomotive that moves backwards. He described an instance in which one line of rail moved 14 in. with traffic, while the other remained stationary. In another instance, involving newly-laid rail, both rails moved against traffic while the track was being raised. This problem was solved, he said, by reversing the rail anchors.

Mr. Denney offered the theory that the irregular creepage of rails might be attributed to conditions created as a consequence of the fact that the two lines of rail are laid at different times and under different temperatures. Mr. Chinn referred to his experience that it has usually been the right-hand rail that moves backward and that this would indicate that the question of expansion has no bearing on the problem. He said he had heard the opinion expressed that the irregular creepage of rails was due to forces originating in the counterbalancing of locomotives.

An instance was related by J. M. Miller (W. M.) involving track on an 8-deg. curve and a 1.75-per cent grade, in which the right-hand rail ran backwards while the other rail moved forward. This situation was likewise handled by reversing the anchors. G. L. Sitton (Sou.) said that no instance had come to his attention in which the rails on double track lines had moved against traffic. He related an instance involving creepage of the rails in opposite directions, which had led him to believe that the counterbalancing of locomotives might have something to do with the problem. However, J. J. Clutz (Penna.) pointed to the fact that this phenomenon has occurred in electrified territory on his road.

The Roadmaster's Qualifications and Duties

Report of Committee

FOR the purpose of this report we shall consider the terms "roadmaster" and "supervisor" as synonymous. Someone has said that no transportation system is better than its maintenance. In railroading maintenance is divided between the maintenance of equipment and the maintenance of roadway and structures. The maintenance of way department is such an important part of railroading that it is referred to as the very foundation of the railroads. Thus, a tremendous responsibility falls upon those men whose duty it is to originate maintenance of way policies or to execute them. Not the least important among such men is the roadmaster.

Before discussing the roadmaster's qualifications and duties, let us first see who he is. The roadmaster forms the link in the maintenance of way department between the management, or representatives of the management, and those charged with actually doing the work. Upon the suggestions and recommendations of this man, maintenance programs are formulated and, in turn, after approval by the management, he is given the responsibility of executing the programs. When it is considered that $425,000,000 was spent on the maintenance of way and structures by the railroads of this country in 1938, we can well see that this man has a large responsibility for getting the maximum return from these maintenance dollars. For this very reason a railroad's investment in a roadmaster is astonishingly large. Some place it as high as $25,000. With this in mind, his qualifications are important.

J. M. Miller
Chairman

To enumerate all of the necessary qualifications and duties of a roadmaster would be to describe the ideal railroad maintenance man. Inasmuch as man is by no means perfect, we will probably never see the ideal roadmaster, although we all have known men who, in our minds, have come near being the ideal maintenance man.

The Roadmaster's Qualifications

To begin with, a roadmaster should have what is commonly referred to as a sterling character. He should be honest and upright in all of his dealings, intelligent, forceful and energetic. He should in all ways conduct himself in such a manner as to hold the respect of his men at all times. He should have ability and personality, for he is a leader of men. His duties bring him in contact with a large variety of men and he should be able to handle any condition that may come to his attention. He should be

interested especially in keeping the roadbed in the best possible condition.

A roadmaster should love his work, or, in other words, he should be "cut out" for such work. This is the prime qualification for a man engaged in any line of work; the lack of this qualification is responsible for more failures than any other cause. Many men who never get anywhere in track work do not realize that the reason is the lack of this qualification.

It is undoubtedly true that the majority of the men who start in track work would have done better in some other line of work. However, this holds true in any line of endeavor, for the reason that most young men, when starting to earn their way, accept the first job that is offered them, regardless of whether they are particularly fond of that class of work. A man should never be appointed a roadmaster until he has shown conclusively that he is deeply interested in track work and has demonstrated a complete knowledge of track work through experience in its construction and maintenance and in its action under trains.

Training and Education

To be a successful roadmaster, a man must have had a thorough training in the details of performing track work, preferably under men interested in and capable of seeing that he is taught correctly. Along with training in doing the work, there goes a very necessary ally—education. To be a successful roadmaster a man must never be satisfied with what he knows about his work, but must always be striving to learn more by contact with other men, by reading of current approved practices in maintenance journals, and by studying books and pamphlets pertaining to track work in its different phases. One of the best evidences that a man is not satisfied with his present store of knowledge is his enrollment in a correspondence course with an outstanding school, or in some other way endeavoring to improve his education and technical knowledge.

There are two well-founded schools of opinion with reference to the education and technical ability necessary to advancement to the position of roadmaster. Many roads favor the practical man who has come up through the ranks. It is pointed out that the maintenance standards of today have largely been established upon the ability of these men. It is said that when a man starts in as a trackman and shows unusual interest in his work, has ability to master it and to advance to assistant foreman, foreman, assistant general foreman and on up the ladder, a road has a man who is capable of handling all the details of any emergency, who knows all the fundamentals of track work, who is interested in his work, who appreciates his road's recognition of his services and, above all, is contented. This system of advancement from the ranks is said to stimulate trackmen to seek advancement, and act as a balance wheel otherwise.

Special Trackwork Requires Special Attention on the Part of the Roadmaster

Some roads favor the man with technical knowledge for the roadmaster's job. It is contended that the better education of engineers gives one a decided advantage over the practical experience of those who advance from the ranks. It is maintained that the engineer can overcome his lack of knowledge of details of maintenance more quickly than a practical man can learn the details of laying out programs, conforming to standards, comparing costs, judging the efficiency of tools and machines, etc.

Such a background causes this type of roadmaster to be much sought after. He is capable of advancing to higher positions in the general organization. Furthermore, some roads use this position as a stepping stone for men of technical training to supply their future officers in other capacities. It must be recognized that only the larger roads can do this as the supply of men of this type will far exceed the opportunities, and the men so trained and advanced will sooner or later reach the point of stagnation, become dissatisfied and seek employment elsewhere. Here again enters the railroad's investment in the roadmaster. No road can well afford to have trained, capable, efficient and energetic men leave its service because of lack of opportunity for advancement.

A man properly trained and educated should know what a day's work is and what he has a right to expect of his men. If he does not know this, he is lost. Nothing will cause men to lose respect for a superior officer more quickly than to be criticized for a job which was really done well and efficiently, or the failure of a superior officer to detect that a job has not been done well.

Executive Ability

A roadmaster should always show the proper respect to his subordinates and to anyone else with whom his duties may bring him in contact. He cannot do this with a high degree of efficiency unless he knows human nature and unless he learns how to handle each of his subordinates so as to get the best possible results. A roadmaster must know which method will work best with each of his men. He should be a leader of men.

To be a successful roadmaster, one must have an interest in each man on his subdivision and be anxious to teach his men all that he can. He must have an interest in teaching and know how to teach, so that when he teaches it can be understood. Men differ with respect to their ability to learn. Some men catch on quickly, while a great deal of patience and reiteration are required with others in order to impress facts upon their minds. Some men do not have the faculty of making themselves understood sufficiently well, largely because of the fact that while they understand what they are talking about they do not realize that the party to whom they are talking does not understand it.

A roadmaster should be imbued with the spirit of fairness, should be free from prejudices and able to control his temper. He must be interested in the personal welfare of each man on his subdivision and in the welfare of their families. He must be deeply interested in the safety of each of his men and must be able to keep them interested in their own safety and that of their associates.

A roadmaster should, by his record, establish confidence and dependability. He must not only be willing but anxious to carry out the instructions he receives, and his superior officers must be able to know at all times that he is on the job, that he will carry out promptly any instructions issued, that he can be depended upon to do the right thing in an emergency, and to plan and carry out his work effectively and efficiently at all times.

A roadmaster must have business ability. He must be able to write or dictate letters in accordance with accepted business standards. He must

have the ability to be brief, yet thoroughly understood. He must have a general, if not a specific, knowledge of his office routine. He must know that all time shown on labor sheets is properly distributed. He should have a general knowledge of accounting. He should have an analytical mind and be quick to grasp a situation and to act wisely, promptly and efficiently in an emergency.

A roadmaster should be loyal. Quite often managements issue orders for certain work to be done which to our way of thinking is questionable. A deep sense of loyalty dictates that a roadmaster will do as instructed promptly, and endeavor to find out the reason later. Many maintenance dollars have been wasted by disloyal employees in the past.

A roadmaster should be resourceful. He should be able to exhibit keen foresight, almost to the point of being a prophet. Many emergencies are averted by a roadmaster's "seventh sense". And last but not least, he should be always available, enthusiastic, cheerful and ready to serve.

A Roadmaster's Duties

A roadmaster must have a complete and detailed knowledge of his entire territory in order that he can program his allotment intelligently. He must know the condition of his railroad and make recommendations for minimum requirements for the men and materials for its proper maintenance. His judgment along these lines must stand the test of investigation by his superior officers. Nothing belittles a roadmaster in the eyes of his superior officers more than to have established a reputation for himself as asking for too much of this or too little of that—in other words, using bad judgment. He must be armed with and give facts. He must know the trend of conditions of each item of his work and take steps to correct a downward trend, insofar as it lies within his power to do so. He must keep his superior officers advised as to trends and actual conditions at all times.

A roadmaster must see to it that the work on his division is performed efficiently and in a workmanlike manner. This implies knowledge of the qualifications of all subordinates, and of the quality and quantity of work that each subordinate actually performs. He must be able to detect any lost motion at its incipiency and correct it before any appreciable amount of money is lost.

He must be thoroughly familiar with the physical characteristics peculiar to his territory and to the country his tracks traverse. He should be familiar with the seasonal reactions of his track, their control and the factor of safety to employ. He must constantly strive for improved methods, studying all possible sources of information. He must be interested in new devices and appliances and be able to determine the good and the bad after minimum experience with them.

He must maintain an organization of highly interested men and must train and teach them how to do their work to the best advantage. He must encourage safety and teach his men how to improve their work. He must, by example, maintain the morale of his men at a high level. He must be sober and diligent. He must see that no materials are wasted and that serviceable materials released from points of heavy traffic are used where traffic is lighter, whenever it is economical to do so. He must investigate and be able to instruct his men in the use of tools and machinery to get maximum use for minimum cost and insure that they are used in a safe manner.

He must inspect tracks and structures by riding trains and motor cars, and by walking, to see that his foremen are maintaining their track in a safe condition. He must see that slow orders are placed when necessary and see that they are removed as soon as possible; that foremen are making inspections of tracks, bridges and culverts before and after storms, etc. He must supervise, when possible, all important and hazardous jobs. He should be an expert on line and surface, particularly the lining of curves and of correct superelevation.

A roadmaster should be familiar with all right-of-way line fences, cattle guards and overhead structures, and should correct unsafe conditions or have them corrected. He should see that foremen are provided with the current timetable, manuals and standards governing their work. He should see that the property under his jurisdiction is kept in as orderly appearance as is consistent with authorized expenditures. A roadmaster should be thoroughly familiar with all types of derailments, be able to assist in the investigation of the cause of any derailment in an unbiased manner, reach a decision promptly upon the completion of the investigation, and correct the condition at once if within his power. A roadmaster should be able to conduct investigations relating to his own men and department in a fair and just manner, and to administer discipline impartially.

He must be an apostle of safety. He should take pains with his appearance, dress neatly and be well groomed. He should respect his superiors — his subordinates should respect him.

Recommendations

It is recommended that a roadmaster have the equivalent of a high school education, be familiar with the practice and theory of the stringlining of curves, and have a thorough knowledge of proper superelevation and how it is arrived at. He should be able to read and decipher blueprints and standards.

Committee—J. M. Miller (chairman), div. engr., W. M., Cumberland, Md.; B. E. Haley, gen. rdm., A. C. L., Lakeland, Fla., (retired); W. O. Frame, supt., C. B. & Q., Centerville, Ia.; W. S. Hofford, ch. clk., U. P., Los Angeles, Cal.; G. S. King, supv., Sou., Blackville, S.C.; J. H. Lynch, rdm., C. R. I. & P. (retired), Chickasha, Okla.; F. H. Masters, ch. engr., E. J. & E., Joliet, Ill.; G. B. McClellan, rdm., T. & P., Marshall, Tex.; G. L. Sitton, ch. engr. m. w. & s., Sou., Charlotte, N.C.; W. H. Sparks, insp. trk., C. & O., Russell, Ky.; G. E. Sterling, rdm., C. & N. W., Eagle Grove, Ia.; G. E. Stewart, rdm., S. P., Merced, Cal.; R. H. Smith, vice pres. & gen. mgr., N. & W., Roanoke, Va.; G. G. Smart, gen. rdm., G. N., Seattle, Wash.; H. W. Steger, supv., Jacksonville Term., Jacksonville, Fla.; B. S. Swim, rdm., T. & P., Bunkie, La.

Discussion

W. H. Sparks (C. & O.) called attention to the fact that in recent years there has been a change in the method of selecting supervisory officers. Formerly, practically all roadmasters were selected from among practical trackmen and the track laborers and section foremen knew that they had an opportunity for advancement and were thus stimulated to do better work than is sometimes the case today where selections are made largely from members of the engineering force. In this connection Mr. Sparks emphasized the necessity that a roadmaster should be qualified to do any of the work of which he is in charge, so that the men under him will recognize that he is expert in his work, stating that he had seen more than one case where the men had lost respect for a roadmaster because he was not familiar with the details of the work of which he was in charge.

He also emphasized the desirability that the roadmaster fulfill all of the requirements mentioned in the report. Today, methods having changed from hand work to power machines, the new generation of supervisory officers must be able to conform to the new conditions which are now confronting them.

F. J. Liston (C. P. R.) believed that it was a good thing that young

men with engineering training are coming into the maintenance organization, but they should realize that to be successful they should start at the bottom and work up through the ranks, that is, from laborers to foremen and, as their training develops, to higher positions. "However," Mr. Liston said, "there should be no rigid rule that only engineers will be appointed to the position of roadmaster, but the way should be left open for the practical men to rise to better positions if they show the necessary qualifications."

Armstrong Chinn (Alton) commended the report, for it emphasized the fact that a roadmaster must be a high-class man. He had nothing to say against technical education but emphasized that an education without the requisite energy and desire to get ahead and make the most of himself is of no benefit to any man. In other words, while education is necessary to get ahead, it should not be understood that one must go to college to obtain knowledge, for it can be acquired from everyday contacts.

G. L. Sitton (Sou.) stated that there is no substitute for hard work and that, in his opinion, no preference should be given the practical man or the engineer, but every man who shows capacity and industry should be given a chance to advance.

The Track Supply Exhibit

Lem Adams
President

FORTY-FIVE manufacturers of equipment and materials used in the construction and maintenance of track, under the auspices of the Track Supply Association, presented an exhibit of their products in connection with the meeting of the Roadmasters Association, the exhibit being held in the Hotel Stevens, Chicago, immediately adjacent to the convention meeting room. The exhibit was exceeded in size in recent years only by that of 1937, when 53 companies participated.

The officers of the Track Supply Association who arranged for and were responsible for the conduct of the exhibit were: President, Lem Adams, vice-president, Oxweld Railroad Service Company, Chicago; first vice-president, R. J. McComb, vice-president, Woodings-Verona Tool Works, Chicago; second vice-president, E. C. Argust, vice-president and secretary, Morden Frog & Crossing Works, Chicago; secretary-treasurer, Lewis Thomas, general sales manager, Q and C Company, Chicago; directors, R. M. Blackburn, Buda Company, Chicago; Jess Mossgrove, Austin-Western Road Machinery Company, Aurora, Ill., (ex-officio); H. C. Mull, Warren Tool Corporation, Warren, Ohio; H. M. McFarlane, O. F. Jordan Company, East Chicago, Ind.; F. P. Cullen, Cullen-Friestedt Company, Chicago; W. W. Fitzpatrick, Nordberg Manufacturing Company, Chicago; and H. C. Hickey, The Rail Joint Company, Inc., Chicago.

In the election of officers for the ensuing year Mr. McComb was advanced to president and Mr. Argust to first vice-president; Mr. Blackburn was elected second vice-president, and Mr. Thomas was re-elected secretary-treasurer. The new directors elected were Geo. Morrow, Reade Manufacturing Company, Inc., Chicago; F. H. Philbrick, Power Ballaster Corporation, Chicago; and J. C. Rinehart, Eagle Grinding Wheel Company, Chicago.

A list of the exhibitors, together with products on exhibit and names of their representatives follows:

Exhibiting Members

Air Reduction Sales Company, New York; welding and cutting equipment; oxygen and acetylene regulators; pipe welding, rail cropping, butt-welded rail; built-up rail joints; flame cleaning torch —C. B. Armstrong, A. W. Brown, C. A. Daley, J. F. Franzen, J. W. Kenefic, L. C. McDowell, U. F. Portell, E. F. Turner and M. M. Weist.

Alcoma Railway Equipments, Chicago; Neal tie pullers, movies of tie puller, Evertite rail joint—C. O. Bradshaw, E. C. Neal, and Geo. Neal.

American Fork & Hoe Company, Cleveland, Ohio; rail anchors; tapered rail joint shims; shovels; weed cutters; forks, rakes; scuffle hoes; broom rakes; axes; hammers, scythes—H. S. Johnson, D. L. O'Brien, John Skeel and R. J. Whalen.

Armco Railroad Sales Company, Middletown, Ohio; sample of pipe; sub-drainage charts and photographs—R. Y. Barham, E. T. Cross and E. Harbeck.

Lewis Thomas
Secretary-Treasurer

Barco Manufacturing Company, Chicago; gasoline tie tampers; gasoline hammer—F. N. Bard, W. J. Belhke, C. O. Jenista, W. T. Jones, J. L. McLean, C. L. Mellor and F. B. Nugent.

Buda Company, Harvey, Ill.; section motor car; inspection motor car; mechanical tie tamper; switch stand; bonding drill; track drill; track liner, rail bender; journal jacks; track jacks; hydraulic jacks, pole jacks, and tie spacers—H. C. Beebe, R. M. Blackburn, H. S. Brown, R. B. Fisher, F. L. Gormley, W. H. Haas, R. K. Mangan, Wood Sanford and G. A. Secor.

Creepcheck Company, Inc., Chicago; rail anchors—T. D. Crowley and N. A. Howell.

Crerar, Adams & Co., Chicago; track and bonding drills; track tools; wrenches; handles and track gages—H. Besant, Geo. J. Doyle, A. Kopala, I. E. Poehler and J. M. Temple.

Cullen-Friestedt Company, Chicago; moving pictures of Burro locomotive crane in operation; rail tongs—K. J. Beller, L. B. Bertaux, C. J. Bronez, E. V. Cullen, F. J. Cullen, F. P. Cullen, T. G. Frazee, G. H. Goodell, Robert W. Jamison, F. L. Kendig and Jos. F. Leonard.

deSanno & Son, A. P., Philadelphia, Pa.;

Radiac grinding wheels—D. F. Madigan, L. G. Martin, E. J. Rohan and W. K. Whelan.

Duff-Norton Manufacturing Company, Pittsburgh, Pa.; track jacks; power jacks; journal jacks; automatic lowering jacks; tie spacers—C. N. Thulin and E. E. Thulin.

Eagle Grinding Wheel Company, Chicago; grinding wheels—John Abram, L. E. Buckingham, R. S. Lloyd and J. C. Rinehart.

Elastic Rail Spike Corporation, New York; Elastic rail spikes—C. M. Bernuth, William A. Fisher, A. C. Jack and B. Kuckuck.

Electric Tamper & Equipment Company, Ludington, Mich.; electric tie tampers—H. W. Cutshall, J. F. Hensel, C. Jackson, L. S. Osborn, G. L. Walters and J. M. Webb.

Fairmont Railway Motors, Inc., Fairmont, Minn.; inspection cars; section car—C. P. Benning, W. D. Brooks, Kenneth Cavins, W. G. Day, Arthur R. Fletcher, C. H. Johnson, W. F. Kasper, J. T. McMahon, V. Pagett, H. W. Protzeller, C. L. Rager, W. H. Ripken, H. A. Sly, Ira Sublett and William Williamson.

Hayes Track Appliance Company, Richmond, Ind.; models of bumping post and wheel stops—S. W. Hayes, S. W. Hayes, Jr., Herbert J. Mayer and John H. Sullivan.

Illinois Malleable Iron Company, Railroad Division, Chicago; rail anchors—Chas. G. Ericson, Dayton T. Hogg, John C. Kuhns and H. A. Morean.

Jacobsen Manufacturing Company, Racine, Wis.; motor scythe; power lawn mower; gasoline motors—Martin Christensen and A. H. Roper.

Jordan Company, O. F., East Chicago, Ind.; model and pictures of spreader ditcher—A. W. Banton, O. L. Champion, J. C. Forbes, H. M. McFarlane and C. W. Shipley.

Kalamazoo Railway Supply Company, Kalamazoo, Mich.; one-man inspection car; light section motor car; signal maintainer car; motor-car wheels; and track gage and level—Ralph E. Keller, Frank E. McAllister, E. C. Poehler and P. J. Robischung.

Link-Belt-Speeder Corp., Chicago; photograph of shovels, locomotive cranes—L. P. Spillan and N. A. Weston.

Lundie Engineering Corporation, New York; tie plates; tie tongs—L. B. Armstrong and O. W. Youngquist.

Maintenance Equipment Company, Chicago; switch point protector; rail and flange lubricator; derail; and literature on rail layer—D. M. Clarke, E. Overmier, T. E. Rodman, R. J. Shanahan and P. A. Wells.

Mall Tool Company, Chicago; equipment for railroads includes gasoline and electric rail grinders; cross slotters; concrete vibrators and surfacers; bridge and building machines; gasoline and electric saws; gasoline and electric drills; power wrenches; flexible shaft grinders and polishers—W. H. Guppy, J. Innes, A. W. Mall, F. A. McGonigle and M. Rhenquist.

Metal & Thermit Corporation, New York; Thermit-pressure; rail welds and electric welding rods—A. Lucas, W. B. Sharav and C. D. Young.

Morden Frog & Crossing Works, Chicago; heat-treated forged compromise joints; adjustable rail braces; and miscellaneous forged fittings for switches—E. C. Argust, W. Homer Hartz, Charles Kane, G. F. Killmer, L. I. Martin and L. C. Reebs.

Nordberg Manufacturing Company, Milwaukee, Wis.; rail grinders; track power drill; power track wrench; utility rail grinders; surface grinders; precision grinders; accessories—C. P. Clemmens, W. W. Fitzpatrick, C. K. Jensch and H. H. Talboys.

Northwestern Motor Company, Eau Claire, Wis.; bridge and building gang car; all service section car; all service section car chassis; light all service car; one-man inspection car—F. W. Anderson, Otis B. Duncan, Geo. H. Goodell, C. E. Murphy, A. H. Nelson, Geo. Prest and W. J. Roehl.

Oxweld Railroad Service Company, Chicago; oxy-acetylene welding and cutting apparatus; oxygen; acetylene; carbide; actual examples of battered joint reconditioning; rail butt welding; angle bar welding; switch point welding; frog welding; application of switch point protectors; and heat-treating of rail ends—Lem Adams, D. Arnold, M. C. Beymer, G. P. Bogert, M. Burnett, Jr., W. E. Campbell, F. J. Duffie, F. M. Finsthwait, H. V. Gigandet, E. B. Hall, Jr., R. A. Heaney, W. A. Hogan, S. B. Hopkins, P. Hunter, Jr., Wm. Leighton, G. B. Moynahan, D. H. Pittman, J. H. Rodger, H. W. Schulze, J. C. Stephenson, F. C. Teichen and J. E. Winslow.

P. & M. Company, Chicago; rail anticreepers and bond-wire protectors; and tie plate assemblies—S. M. Clancy, J. S. Gallagher, J. L. Grant, D. T. Hallberg, G. E. Johnson, J. E. Mahoney, W. A. Maxwell, F. A. Preston, Max K. Ruppert and G. T. Willard.

Pettibone Mulliken Corporation, Chicago; mechanical switchman; switch stands; hub stands and hub safety switch stands—J. H. Asselin, A. R. Hearl, C. A. Johnson, Carl Landberg, G. R. Lyman, W. E. Olds and G. J. Slibeck.

Pocket List of Railroad Officials, New York; copies of Pocket List of Railroad Officials—H. A. Brown and B. J. Wilson.

Positive Rail Anchor Company, Chicago; rail anchors; guard-rail plates and braces; adjustable rail braces—L. C. Ferguson and R. J. Platt.

Power Ballaster Company, Chicago; motion pictures of power track ballaster and power track cribbing machine—W. E. Bugbee, Ralph Payne, F. H. Philbrick, L. L. Schreck and Stanley H. Smith.

Q. & C. Company, New York; guard-rail clamp; switch-point guard; compromise joints; derail; gaging tools; wheel stops; rail tongs; gage rods; flangeway guard; adjustable rail brace; electric switch heater—G. H. Goodell, L. E. Hassman, E. I. Hetsch, G. Prest and Lewis Thomas.

Rail Joint Company, Inc., The, New York; insulated rail joints; standard joints; compromise joints; and fibre insulation—V. C. Armstrong, E. W. Backes, Alex Chapman, W. E. Gadd, Harry C. Hickey, G. H. Larson, J. N. Meade, R. W. Payne and Thomas Ryan.

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Railway Engineering and Maintenance, Chicago; copies of *Railway Engineering and Maintenance* and *Railway Age*—G. E. Boyd, M. H. Dick, L. R. Gurley, S. W. Hickey, N. D. Howard, Elmer T. Howson, F. C. Koch, H. E. McCandless, H. A. Morrison and J. S. Vreeland.

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Reade Manufacturing Company, Inc., Jersey City, N. J.; literature and photographs on weed control—D. M. DeWitt, George Morrow, C. A. Parish, Charles H. Reade and Charles F. Reade.

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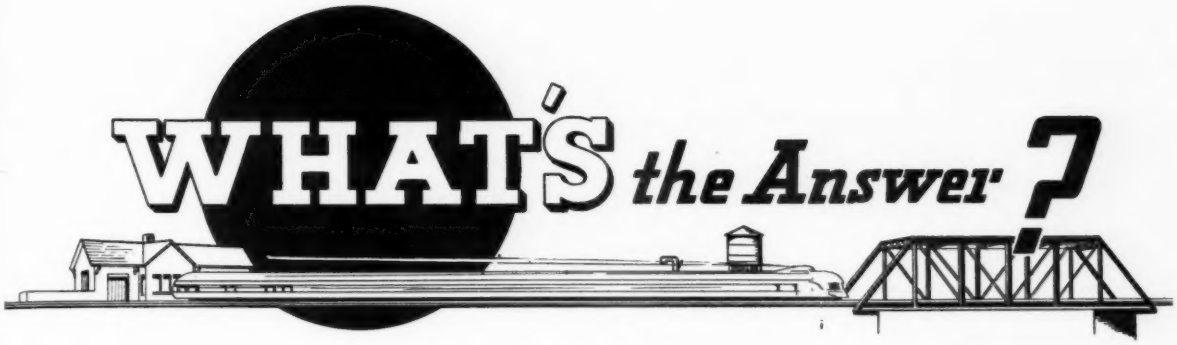


When to Cut Brush

What is the best time to cut brush with the view to preventing or retarding further growth? Why?

Gives Specific Data

By Paul McGuire
Section Foreman, Atchison, Topeka & Santa Fe, Fairfax, Okla.

The United States Department of Agriculture, Miscellaneous Publication No. 194, states that woody shrubs, bushes and young tree sprouts can best be controlled by being cut at the proper time, and quotes Bulletin 272 of the Kansas Agricultural College:

"Investigations at this station have shown that the effectiveness of mowing is governed to a large extent by the organic-food reserves in the plants when they are cut. This work was most effective when it was done at the low point in the organic-food reserves. Mowing the plants when the food reserves were high had little effect. This was demonstrated in experiments conducted in the eradication of buckrush, sumac, etc. Buckrush can be eradicated entirely in three annual cuttings made early in May, while if the cuttings are delayed until July 1, few, if any, of the plants will be killed."

Work at the Connecticut Agricultural Experiment Station shows that the July mowing of brush, such as soft maples, alders, white (gray) birches, blackberries and others, is most successful for eradicating them. In the northern states the critical period for brush is apparently when the roots contain the smallest amount of starch. On the average this is at the time of blooming.

The eradication of bushes, sprouts and woody shrubs in the southern states appears to be more difficult than in the North. Grubbing them out or killing them with a plant poison has seemed, so far, to be the only sure way to eradicate them. Both of these methods are expensive unless labor is cheap.

By following the foregoing practices, I have succeeded in eradicating 95 per cent of the brush from my section, and, where it is reseeded from outside sources, it can be controlled by cutting every second year.

August Best Time

By P. O. Ferris
Chief Engineer, Delaware & Hudson, Albany, N.Y.

A short answer to this question would be to say during the month of August, since the growth is farthest advanced at this time and sprouting is less likely to occur at this season. Yet there are reasons why brush should be cut at other times, the advantages at these other seasons having no connection with the prevention or retarding of its growth, but arising from the location of the brush, because it obstructs the view, or because men are more readily available to do the work. Unless necessity calls for cutting brush because it obscures the view, as around curves, at grade crossings or at signals, the most advantageous time to remove it is, generally, when the right of way is being mowed, usually during July or August.

Brush creates problems at other places, however, and must be controlled. If allowed to grow, it may interfere with telegraph and telephone lines, clog waterways and ditches, damage the masonry of culverts and bridges and interfere with snow fences and right-of-way fences. In these cases it becomes necessary to remove the brush without waiting for the usual cutting season. So far as the cutting of brush depends on the availability of forces to do the work, the best time is after the ground is frozen. This is especially true today since the

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions you wish to have discussed.

To Be Answered in December

1. *What step can the section forces take to increase the service life of rail?*

2. *Where a concrete floor exhibits a tendency to dust, what means can be employed to overcome the trouble?*

3. *What measures should be employed to insure the maintenance of line and surface at turnouts?*

4. *What is the most satisfactory method of fastening blast plates to open-deck steel structures? To steel structures with concrete floors? To masonry structures?*

5. *Should foremen be allowed to keep on hand a stock of supplies and extra parts for motor cars? If so, what stock should they carry? If not, why?*

6. *What is the maximum rate at which treated water should rise in a continuous process tank to insure the removal of all precipitated solids? Is a lower rate than the maximum desirable? Why?*

7. *When necessary to use thick shims, should gage rods be used to reduce the amount of bracing? If not, why? If so, what should be the relation between the thickness of the shims and the number of gage rods?*

8. *What causes varnished surfaces to spot? What can be done to prevent this?*

limited forces now available should be kept on the track as long as the ground remains free from frost.

Winter Most Convenient

By G. S. Crites
Division Engineer, Baltimore & Ohio, Punxsutawney, Pa.

To keep brush down, it should be cut when the sap is running at its fullest. The sap will then vent largely to the atmosphere from the stumps and the supply of plant food available for low-growing shoots will be limited. Usually, however, at the time the sap is running in the brush the track is coming out of the winter in a condition that calls for close attention by all of the forces available. Work must then be concentrated on the track, leaving no time for cutting brush on the right-of-way. For this reason, clearing and grubbing should be done with the least possible interference with the program of track maintenance.

Where the track freezes during the winter, the clearing and grubbing should be done during this season. Then, before the seeding time of the right-of-way vegetation, the new growth of the brush can be mowed readily in connection with the mowing of the right-of-way.

Where the tracks do not freeze, the clearing and grubbing should be done at the time the seed pods are starting to form. This will prevent seeding and the sap will run out of the freshly-cut stubs, retarding fresh growth. The main point that should be kept in mind constantly, however, is to get the clearing and grubbing done with the least possible interference with necessary track work.

Preparing Plaster for Tinting

How should an old hard-finished plaster surface be prepared for tinting?

Clean and Smooth

By E. C. Neville
Bridge and Building Master, Canadian National, Toronto, Ont.

Old hard-finished plaster surfaces usually show numerous fine cracks which develop as the plaster dries out. Sometimes these cracks are not very noticeable, but after a coat of paint is applied they become quite prominent by reason of the fact that they absorb more oil from the paint than the remainder of the surface does, making it easy to trace them when the paint becomes dry. To overcome this it is the usual practice to apply a coat of sizing, which acts as a filler, preventing absorption of the oil from the paint, but in all cases the plaster should be rubbed down with fine sandpaper to remove any loose particles, using care not to scratch or roughen the surface, after which it should be dusted off with a hair duster. Where large cracks or holes appear, the edges should be scraped to remove loose material, and should be soaked with water. The cavity should then be filled with plaster of paris, pressed firmly into the cracks as smoothly as possible and, after it has hardened thoroughly, it should be sandpapered to a smooth surface. Where plaster walls have been treated previously with calcimine or similar finishes, this should all be removed before applying the paint.

Plaster surfaces should receive two coats of paint in addition to the priming coat, but when a coat of sizing has been used and the pores are well filled, the priming coat may be eliminated, provided the surface is in good condition and not blotchy. Many pleasing effects may be obtained by painting interior plaster surfaces, but where plain light colors are used, a flat finish is desirable, because it is easier to keep clean by washing.

Filling Cracks Essential

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

An answer to this question requires mention of certain phases of the application of the plaster, especially in those cases where wood laths were used and which are generally found under old plaster. If the laths were not well seasoned, free from sap, bark and dead knots, it is quite certain that they have stained the plaster, and this must be taken into account in selecting the color for the finish. Plaster is generally applied to lath in three coats, the first being the scratch coat; the second, the brown coat; and the third, the skim or finish coat, which is white. Where the plaster is applied to brick or stone surfaces, the scratch coat is generally omitted.

Among the points to be considered in the treatment of interior wall surfaces are beauty, cleanliness and economy. Beauty applies to color, style and finish; cleanliness depends upon the facility with which the surfaces can be washed without damage to the finish; and economy has to do with first cost, the cost of maintenance and the length of service life. These three are generally dependent on the condition of the plaster before the tint or paint is applied.

Before starting to prepare an old hard-surfaced plaster for tinting, one should first make a close and careful inspection, to determine the condition of the surface, whether the plaster is otherwise in good condition and whether each coat is well bonded to the preceding coat. In many cases the failure of paint on plaster surfaces can be traced to air suction through porous material, sappy laths and the presence of dead knot holes in the lath. If any part of the plaster has a hollow or "barrel" sound, it is usually because the finish coat was applied before the previous coat had dried completely. In such an event, the only safe thing is to cut out the defective area and replace the plaster with a new coat. The next step is to fill all cracks and small holes with patch plaster, Swedish putty, which was described on page 737 of the October, 1937, issue, being an excellent material for this purpose. The filling of cracks is essential to good appearance and permanent results. Where cracks and small holes require attention, they should be cut out in the shape of an inverted V.

Plaster that has been painted previously with an oil paint and is in good condition, need not be primed, as the old paint will act as a primer. If it has not been painted, it should be washed with a solution of alum. It should then be allowed to dry, after which it should be sponged and oiled. Obviously, a painted surface should be washed to remove all loose paint, dirt, grease and other deposits. If a flat coat is to be applied, the gloss paint from previous treatment should be roughened by rubbing with steel wool or fine sandpaper.

Always Use Shellac

By Supervisor of Buildings

Obviously, one of the important items in preparing an old hard-finished plaster surface for tinting, as on all surfaces to be painted, is that of cleaning. All dirt, grease, calcimine, and loose particles of plaster should be removed by washing and the surface should be allowed to dry

thoroughly. If the plaster is cracked, the area around the crack should be scraped or sandpapered until both sides are flush with the general wall surface. Small cracks should be opened with a putty knife or a trowel throughout their length to permit filling them with one of the materials now on the market, with plaster of paris or with Swedish putty. If plaster of paris is used, a small amount of glue will improve it. When the plaster and the patched area are fully dried, all uneven surfaces should be gone over with sandpaper.

The surface should then be given a coat of shellac or, in some cases, two coats. If any rough particles appear at this time, they should be sandpapered. Shellac is preferable to glue for sizing, because nothing but alcohol will cut the shellac, while if glue is used, washing the walls with water may cause it to show through the paint. If the wall is to be painted white, white shellac should be used.

Overloading Motor Cars

What practical measures can be taken to prevent the overloading of motor cars?

Enforce Rules

By C. L. Fero
Supervisor of Work Equipment, Boston & Maine, Boston, Mass.

This most important subject should receive serious consideration from all supervisory officers. It can best be controlled by adequate rules governing the care and operation of track motor cars, in which those relating to overloading are given considerable emphasis. Obviously, such rules are of no value unless they are enforced rigidly. I have set down a few principles which are important, which should be embodied in any set of rules governing the care and operation of motor cars, and which should be enforced by supervisors. These are:

1. A section or extra gang should never haul a trailer or push car unless the work programmed for the day actually requires its use. In other words, the extra car should not be hauled daily or even frequently in the expectation that it might come in handy.

2. All surplus tools, that is, tools that are not necessary for the day's work, should be left at the tool house. It has been found that some foremen keep their cars packed with unnecessary tools, rather than to spend the short time required daily to load and unload such surplus items.

3. At least once a week, tool trays should be cleared of all extra material, such as spikes, bolts, scrap, etc. Some cases have been found where accumulations of such materials and scrap have been allowed to remain on the car for months at a time.

4. A definite limit should be placed on the number of ties to be carried, on a trailer unit, this number corresponding with the capacity of the individual unit. This should be specified for both treated and untreated ties. This limit should be based on both the capacity of the trailer and the type and capacity of the motor car that is to haul the trailer.

5. The practice should be discontinued of having section-type motor cars haul heavy equipment, such as air compressors, ballasters, batteries of spike pullers, adzers and other heavy track machines. Control of this practice is in the hands of supervisors.

6. Inspection cars assigned to track inspectors should be limited specifically as to the tools and material to be carried, as it has been found on more than one occasion that such cars have been seriously overloaded.

7. The capacity of push cars and trailers should be stenciled plainly on each side of these cars. It is also suggested that the capacities of motor cars be shown on the decks of the cars.

8. Unless an emergency occurs, a rail should never be carried on a motor car.

It is believed that the load of tools and material placed in the trays of a motor car does not cause as much damage to the car as the hauling of exceptionally heavy loads on trailers and push cars. Many belts, clutches and friction drives have been burned and engines and rear driving parts have been strained as a result of attempts to start a heavily-loaded trailer. This is especially likely to happen if the trailer is not in good mechanical condition.

It is most important that the operator call promptly upon the motor-car maintainer or repairman for assistance if he believes that the motor car, the push car or the trailer assigned to him, is not in satisfactory operating condition. At the first sign of trouble, early attention by the motor car repairman will naturally result in better performance and longer life for the equipment involved.

Practice too Common

By George R. Wescott
Assistant Engineer, Missouri Pacific, St. Louis, Mo.

A motor car is overloaded when it is required to carry a load in excess of that for which it was designed or when the car and its load are too great to be handled readily by the gang to which the car is assigned. Cars weighing from 1,500 to 2,000 lb. are generally used by gangs of sufficient size to handle them and are designed to carry any load that is likely to be put upon them. For this reason, there is little danger of overloading them from the standpoint of either the capacity of the cars or the ability of the gang to handle them.

With the cars used by smaller gangs of three to eight men, the situation is somewhat different. The demand that the weight of these cars be kept within the capacity of the gangs to handle them, has led to the building of cars that can easily be loaded beyond their load-carrying capacity. In this class, the size of the gang may change, and a car that is suited for a gang of five to eight men during the working season is too heavy for an off-season gang of two or three men.

A similar situation occurs in the case of the lighter cars that are designed for one or two men. These cars are frequently expected to carry four or more men, and are often loaded with a considerable weight of tools or supplies. During the recent period of small maintenance allowances, there have been many instances where cars of this type were assigned to section use, with the consequence that they have been loaded much beyond their capacity.

It appears that, in general, the overloading of motor cars is ordinarily limited to the smaller cars, that is, those weighing from 1,000 to 1,200 lb. and less. The first requirement to avoid overloading these cars is to assign cars suited to the size and the needs of the gangs. This suggests a frequent check of the cars available against the requirements, in order that every car shall be placed in the service for which it is best fitted. Supervisory officers should watch this carefully and, where possible, transfer to

other service those cars that are unfitted for the service they are now performing.

It is common practice for gang foremen to permit an accumulation of infrequently-used tools or supplies to remain on their cars day after day. This is especially true where the car itself is too heavy for easy handling, so that the additional unnecessary weight is not so noticeable. Foremen should be cautioned frequently about this unnecessary loading and, to discourage this practice still further, the tool space on the cars should be restricted to actual requirements. For example, the space under the seat deck of a section car should be so arranged that heavy tools or supplies cannot be placed in it. For the same reason, in the purchase of new cars, tool space beyond actual requirements should be avoided, and full advantage should be taken of the latest and best designs the manufacturer can offer in reduced weight through the use of high-strength alloys in the construction of the cars.

In many cases, the overloading of motor cars can be traced directly to the fact that a push car for handling materials or a trailer for handling the men was not readily available. Here again, close watch on the part of the supervisory officer may show the way to the correction of a bad situation through a reassignment of push cars and trailers. It is particularly true of modern track motor cars that it is the load-carrying capacity rather than the power that is likely to be exceeded. It is realized that on many roads, the motor-car equipment now in service or available was purchased for quite different conditions than those that now obtain and that, with the best handling possible, some overloading must still be expected.

Skinning Foundation Piles

Is it desirable to skin piles for use in foundations? In trestles? Why?

Increases Skin Friction

By G. S. Crites
Division Engineer, Baltimore & Ohio, Punxsutawney, Pa.

Piles to be driven in either foundations or pile trestles, other than temporary trestles, should have the bark removed. Unless driven to rock, a pile does not act as a column from the tip to the head, but only from the ground up. From the ground line down, the friction between the soil and the surface of the pile plays an important part in providing the necessary reaction to the load.

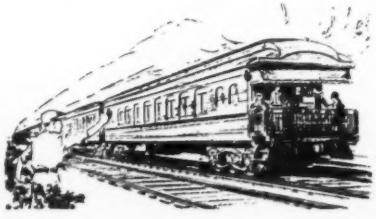
Piles for foundations are usually entirely below the ground line and probably all below the water table, so that skin friction also plays an important part in their bearing capacity. The bark on the tree is not an integral part of the wood but is separated from it by a sappy fibrous membrane. When long covered or submerged, this membrane disintegrates into a slippery film that allows the pile to slip inside the bark covering and thus lose much of its bearing capacity.

Below the ground line, trestle piles act very much as foundation piles do; from the ground line up, they act as columns. In rare cases bark might add very slightly to the strength as columns, but dead bark makes excellent food for insects and microbes, which are wont to set up housekeeping in the bark adjacent to the sound wood in the stick and work into it from these bases. A skinned pile does not offer the same hospitality to insects and decay-producing organisms as a pile with the bark on it. For the reasons given, piles for foundations should be skinned for utility, while piles for trestles should be skinned not only for utility, but also as a protection against the ravages of insects and of the growths that cause decay.

Retards Insect Attack

By H. Austill
Chief Engineer, Mobile & Ohio, St. Louis, Mo.

Insects will usually make a quicker attack on dead timber which has retained the bark than on the same timber with the bark off, and in trestle work the presence of the bark prevents a tight fit for the bracing. Foundation piles may be driven into material of such character that skin friction is depended on for the supporting power, or they may be driven through material possessing very little supporting power into a hard material or to rock. In the latter case the end bearing is depended on for the support and skin friction is of little consequence. In the former case, however, skin friction alone being depended on, unless the bark is of such a nature that it clings to the wood and increases the friction, it should be removed. I do not believe that the presence or absence of bark below the water line affects the life of the wood. It has been found that tight-fitting, unbroken bark will offer fairly good resistance to teredo attack for about two years, and for certain structures in salt water it might be advisable to leave the bark on.



Holds Moisture

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

If the piles are intended to last the full life of the remainder of the members of the trestle, it is not desirable to drive unskinned piles, irrespective of the kind of material in the other members. Bark always loosens eventually from the last growth of the tree and does not permit the underlying wood to dry quickly after a rain. This tendency to hold the moisture in the wood causes the pile to decay more quickly and to fail much earlier than if it had been skinned. The loose bark also increases the fire hazard.

Below the water table in the ground, the skin becomes loose and slippery and thus greatly decreases the skin friction upon which the load-carrying capacity of the pile depends. This may cause serious settlement of the bent. If the pile is driven to rock, other hard material or into gravel, it will make little difference, so far as bearing power is concerned, whether the pile is skinned below the water line. In this case the load-carrying capacity depends mainly on the value of the end-bearing value of the pile and not on skin friction. Where piles are driven in temporary work, it is not economical to skin them, unless their load-carrying capacity would be seriously impaired by not doing so.

The maximum loading that can be placed on foundation piles varies quite widely with the location and local conditions. In some parts of the South, it is necessary to obtain penetrations of from 40 to 75 ft. to reach the maximum loading value, which depends entirely on skin friction and the weight of the material displaced. In such situations, failure to skin the piles may necessitate a marked increase in their

length by reason of reduced skin friction. In other words, if the bark is left on, the structure may be endangered because of settlement, whereas by skinning the pile and allowing it to dry before it is driven, its loading value will be materially increased instead of decreased.

Skin All Piles

By Frank H. Cramer
Bridge Engineer, Chicago, Burlington & Quincy, Chicago

Piles to be used for either foundations or trestles should, by all means, be skinned or peeled soon after cutting. Those for foundations are usually designed to carry heavy loads and their bearing power depends not only on the amount of penetration but on the skin friction between the piles and the various materials they penetrate. For this reason, it is essential that the piles be peeled to insure that the materials they penetrate will make intimate contact with the circumference of the timber. If a pile is not peeled, the bark will loosen in time and, under load, will tend to settle.

Furthermore, the bark of trees is highly resistant to the penetration of preservatives and to make certain that piles will receive adequate treatment to insure a long service life, every opportunity should be given for the wood to become inpregnated with the preservative, and this can be assured only by removing the bark to expose underlying wood to the preservative.

Pile bents and pile piers can be framed better and a better job of joining other timbers to the piles can be done where the piles are skinned. A pile with the bark left on cannot be made to retain a tight fit with other members because the bark soon starts to split and crumble.

Vegetation in Reservoirs

Under what conditions is the growth of vegetation in reservoirs objectionable? What can be done to prevent it?

Does No Harm

By E. M. Grime
Engineer of Water Service, Western Pacific, St. Paul, Minn.

Usually the growth of vegetation in reservoirs used for railway water supply is not extensive except, in some cases, around the shore line where the water is shallow. This does no particular harm, and is not objectionable for any reason other than that it creates an untidy appearance. Reservoirs used as settling basins for turbid water pumped from rivers or muddy streams are usually so coated with silt over the bottoms and sides that vegetation has no opportunity to get a foothold.

Vegetation present in reservoirs used for the storage of drinking water may be beneficial, because the submerged growth may impart a certain amount of oxygen to the water. Yet to some persons it does not look well to see the surface of such reservoirs covered with vegetation, and this unfavorable appearance is sometimes corrected by cutting off the growth a few feet below the surface of the water, using a long piece of band saw in the hands of men working from boats or scows.

When a reservoir is used for harvesting the annual supply of ice, vegetation should not be permitted to grow to a point higher than four feet below the surface of the water, as the surface will stand when freezing starts. In some cases it may be possible to drain the reservoir during the summer, thus permitting the vegetation to be cut with a mowing machine and raked out. Where it is not possible to drain all of the water out of the reservoir, it may be possible to remove a part of it or, when the water is low, one can cut the growth between the normal shore line and the water's edge, and the top of the remaining vegetation may be cut off by a man working from a boat. The floating dead material may then be raked out when wind and wave action have driven it to the shore.

Summarizing these facts, vegetation rarely does any harm in water-supply reservoirs. For this reason, its removal for reasons other than that of appearance is not worth the necessary labor and expense involved.

May Be Annoying

By Supervisor of Water Service

Vegetation, that is weeds, rarely grows in deep reservoirs to such an extent that it becomes a problem, although there may be considerable growth along the shore line if the contour of the ground is such that there is a wide belt of shallow water surrounding the deeper portion of the reservoir. On the other hand, if a considerable area of the reservoir is shallow, weed growth may constitute a serious problem. This is particularly true if the reservoir merges into a swamp, where there is a large accumulation of decaying vegetation. In this event, enough organic matter may be introduced into the water to impair its value for boiler purposes.

There is another type of vegetation that, while not so common as the more familiar aquatic weeds, sometimes creates an annoying problem. I refer to algae, a group of marine plants that thrive and accumulate on the surface of the water in large quantities. Algae make the water objectionable for drinking purposes because they impart a strong fishy flavor to it. Beyond this, however, they may enter or clog the suction line, clog the pumps and interfere with the introduction of the water into the locomotive by clogging the screens.

Fortunately, the removal of these plants is relatively simple, since copper sulphate (blue vitrol) is effective in killing them. Experience has shown that as light a dosage as one part of this chemical in 5,000,000 to 10,000,000 parts of water will kill most of the undesirable forms of algae. Because of its high toxicity to fish, however, it should be used with considerable caution in reservoirs that have been stocked with desirable fish. It has been established that concentrations of this salt representing one part in 3,000,000 will not kill suckers, yellow perch, carp, bass and sunfish, but that trout are much less resistant, although they will not be affected by solutions containing one part of copper sulphate in 7,000,000 parts of water. If the presence of fish does not constitute a feature limiting the use of the poison, one part of the salt in 2,000,000 parts of water will eradicate the remaining algae that are not affected by the weaker solutions, thus clearing the reservoir.

These minute quantities of the poison, when uniformly distributed, will produce no harmful effect so far as the use of the water for drinking purposes is concerned. In view of the fact that only a few applications are needed in any season and that the reservoir is usually receiving new water, while a large part of the copper sulphate is precipitated with the organisms it attacks, and that the same thing occurs by reason of the mineral elements contained in the water, there is ordinarily no objection to its use, if applied under proper supervision. The method of application is usually to fill cloth sacks with the dry salt, lower them from boats and drag them through the water along predeter-

mined lanes until the salt is dissolved. This prevents high concentrations in any one area and hastens the diffusion throughout the whole body of the water.

Eradication of weeds is often difficult because many of them are deep rooted and they often present extremely rank growth. About the best solution where the vegetation must be eradicated is to drain the reservoir to the point where the growth stops and then, after the ground has dried sufficiently, go in with mowers or grub hoes and cut or uproot the plants. It should be kept in mind, however, that only in exceptional cases is the shoreline growth objectionable, except so far as it affects the appearance of the reservoir, and that the benefits from eradication are seldom commensurate with the cost.

Trucking Dirt from Ditches

How far should a section gang be allowed to truck dirt from a cut when cleaning and shaping ditches for winter? Beyond this limit, how should the excavated material be disposed of?

Use Power Equipment

By George M. O'Rourke
District Engineer, Illinois Central, Chicago

Depending on the amount of dirt that must be moved and the time allowed, section men with dump boxes on push cars may be able to truck dirt economically a maximum distance of one-fourth mile. However, if machinery is available, and if there is enough dirt in the cut to permit its operation for several days, or if there is a series of cuts in the same general area to be cleaned, no hand labor should be employed for ditching if it is possible to avoid it, and this can usually be arranged, for few roads are now without ditching equipment.

Where there are several types of excavating machinery to choose from, the machine best suited to the particular work should be selected for each job. Where the right-of-way is wide, a crawler-mounted dragline working from the top of the cut can remove the dirt economically and deposit it away from the edge of the cut. In other cuts a rail-bound ditcher, working either from the track or from cars, may be most suitable. In this case, the excavated material can be loaded into dump cars and unloaded on nearby fills. It should be a fundamental rule that as much ditching as possible be done with power equipment.

Not a Serious Problem

By C. P. Nicholson
Assistant Engineer Maintenance of Way and Structures, Norfolk Southern, Norfolk, Va.

The cleaning and shaping of ditches in preparation for winter should not present a serious problem with respect to the disposition of the material, provided sufficient care is exercised by the section forces to preserve at all times the original standard dimensions and grade of the ditches. The routine cleaning of ditches is a part of the work of the section forces, and any accumulation of silt that might impair drainage must be taken care of from time to time so that the true dimensions and gradient may be maintained as constantly as is practible.

If deferred maintenance has created a large accumulation of silt or other obstructing materials there are methods available at all times to avoid the necessity for expensive work-train service. If the cut is not deep, the material may be cast over the top; if deeper, it may be removed to the top of the bank by using a temporary staging upon which the earth can be thrown and then shoveled from this elevation to the top of the bank and spread, as may be necessary.

Our sections are each equipped with one push car and one dump box for handling such situations. In extreme cases, this equipment may be increased to two push cars and two dump boxes, and the force enlarged temporarily. Under these circumstances considerable material can be excavated and hauled as far as one-half to three-quarters of a mile, to a point where it can be dumped as waste, or disposed of otherwise as occasion may demand. Of course, each load handled to the waste bank decreases the length of the haul, assuming that the work was started at the center of the cut.

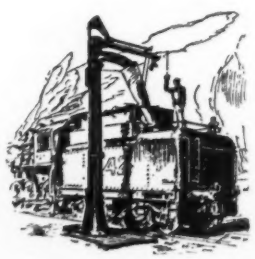
Marking Ties for Renewal

Should ties that are to come out next year be marked at the time of the annual fall tie inspection? How should this be done? By whom?

Not Prior to Allowance

By C. D. Turley
Chief Tie Inspector, Illinois Central, Chicago

In general, the annual fall tie inspection is made not later than October 1, and the tie allowance for the following year is seldom given to the division engineers until January 1 or perhaps later. For the last several years there has been a wide spread between the number of ties requested by the track supervisor and the number finally authorized by the management. In view of these facts, it seems that ties should not be marked at the time of the fall inspection, but that this marking should be delayed until the year's allowance is known. However, they should be marked far enough in advance of the working season to permit systematic progress on the season's program of tie renewals. All ties should be marked at this time, for experience has shown that half-done jobs are seldom finished.



The ties should be marked by the track foreman and checked by the supervisor to insure that they have been properly allotted by miles. Spot painting has proved quite satisfactory for this work and where this is done the marks can be distinguished easily throughout the year. Obviously, the section foreman should be authorized to remove a bad tie or to leave in a good one, regardless of the marking, on condition that he keeps within his tie allowance. Experience has shown that he will seldom vary as much as 10 per cent in any one mile of track. It

has also taught that careful marking of the ties for renewal will bring about a more uniform tie condition than is likely to occur without this formality.

Must Know Timber

By J. L. Monk
Section Foreman, Southern Pacific, Ft. Huachuca, Ariz.

While a track is a track, and if under-maintained the consequences will be the same, regardless of the volume of traffic, an intelligent tie inspection cannot be made except by an experienced trackman who is familiar with the conditions surrounding the line upon which the inspection is being made. He should be familiar with the climatic conditions, the character, density and speed of traffic, as well as a judge of timber and of the service being performed by the ties he is inspecting. Some timbers decay slowly on the outside and appear to be close to the point of failure; yet they may be perfectly sound only a little below the surface. On the other hand, some ties, notably gum-wood ties, may appear to be in excellent condition but be completely decayed on the interior.

In view of this, I am in favor of a rigid and thorough inspection of all ties by a division inspector, who should be accompanied by the foremen of the successive sections he passes over. I believe that the ties that are selected for renewal should be marked at the time of the inspection, so that there will be no doubt or controversy over the matter at a later date.

Sees No Advantage

By W. H. King
Section Foreman, Missouri Pacific Lines, Francitas, Tex.

I see no advantage in marking the ties that are to come out. We indicate the ties that are to be renewed by spotting white paint on the rail immediately above the ties in question. However, I do not believe that even this is necessary, for I confess that we rarely notice these marks when renewing ties, for the ties themselves always carry plain indications of the necessity for renewal. When working track we remove the bad ties, regardless of whether they are marked for renewal. Every trackman knows that there are many ties that look perfectly sound on top that are so badly decayed on the bottom that they have practically ceased to function, and no inspector is likely to catch such a tie.

The annual inspection is rarely accurate with respect to the individual ties that require renewal. Rather it is an approximation of the number of ties that will be needed next year. Usually, a very close approximation is arrived at because, for every bad tie the inspector misses, he is likely to count one that has one or more years service life left. It is my belief that the annual tie inspection should be made by the section foreman; he knowns the condition of his ties and can make a closer approximation of his needs than any one else. Whether the foreman or an alien inspector makes the inspection, I see no purpose in marking the ties.

Advantages of Wire Glass

What are the advantages and disadvantages of wire glass? Where should it be used?

Adds to Safety

By G. S. Crites
Division Engineer, Baltimore & Ohio, Punxsutawney, Pa.

Wire glass is most valuable for those uses in which the glass is subjected to strains or shocks. It possesses considerably more strength to resist rupture than plain glass, with the added advantage that, if a pane is broken, large pieces do not fly out or fall, as practically always happens with plain glass. For this reason, it adds to safety around enginehouses, shops, warehouses, trainsheds and other similar buildings.

Visibility through wire glass is neither as good nor as pleasing as through plain glass, for which reason its use is best confined to places where transmitted light rather than view is desired. Its use in skylights is almost imperative, since it resists temperature stresses much better than plain glass, and large pieces are not likely to fall and thus be a potential cause for injury if a pane is broken. To overcome fully temperature stresses and avoid cracks in skylights, corrugated wire glass should be used, but flat wire glass is far superior to plain glass for skylights. It should be understood that all glazing troubles will not be overcome through the use of wire glass, but its use is fully justified in most cases where the main purpose is to allow light to enter the building, and where glass breakage is a troublesome problem.

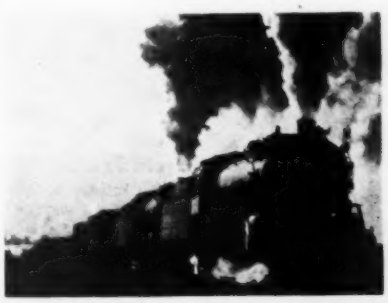
Resists Fire

By General Inspector of Buildings

Among the advantages of wire glass, the principal one is its adaptability for resisting complete failure from the many causes that result in glass breakage. Furthermore, this characteristic also makes its use desirable where shattering may be a potential cause of personal injury. For this reason, it should be specified for skylights; for monitors, especially where they deviate from the vertical; for windows in fireproof buildings, as well as for windows on the sides of buildings that are exposed to fire risks; for elevator enclosures; for fireproof partitions that must have window openings; and, in short, for all fireproof enclosures where glass openings are necessary or desirable.

The property of wire glass that makes it desirable for these applications is that the glass will be held in position by the imbedded wire, even after it is broken. For the same reason, it is particularly adapted for use in skylights and elsewhere, where broken glass might cause serious personal injuries.

Among the disadvantages is the tendency exhibited by practically all wire glass to crack as it departs from the vertical. In general, wire glass installed in vertical sash and exposed to direct sunlight does not show any greater tendency to crack under temperature stresses than plain glass. On the other hand, as the sash is inclined, the tendency toward temperature breakage at once becomes apparent and increases as the angle with the vertical increases. This can be observed in any system of windows having revolving sash for ventilation.



Double Headed, Heavy-Freight Climbing a Grade on the Grand Trunk Western

PRODUCTS of Manufacturers

New Woolery Switch Heater

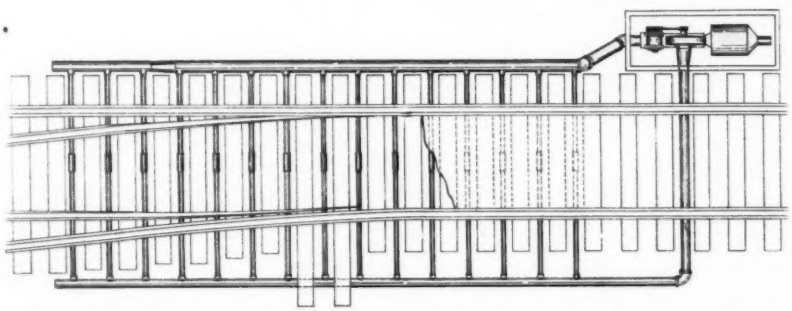
THE Woolery Machine Company, Minneapolis, Minn., has developed a new type of switch heater, known as the Woolery Switch Warmer, in which an electrically-powered oil burner and blower system circulate hot air through pipes under the switch.

The heater unit, which may be set in a small pit, is composed of a compact strongly-built oil burner, a combustion chamber, a pressure blower, an electric motor and a fuel pump, mounted on a channel bed. The 3-hp. electric motor operates at 1725 r.p.m., using 220-volt, 3-phase alternating current and drives the fuel pump and the blower by means of a belt drive. The blower has a rated capacity of 500 cu. ft. per minute at 10 oz. pressure and provides continuous circulation of the hot air through the heating pipes. The blower also induces the draft through the burner, the hot exhaust gases of which are mixed with the circulating hot air, without coming in contact with the blower, insuring a longer blower life.

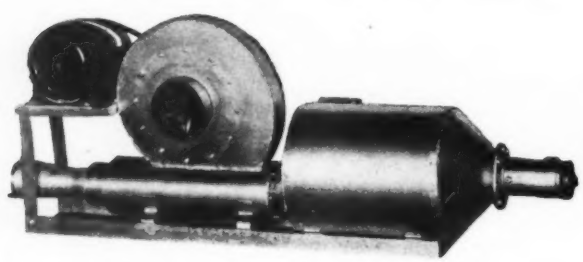
This mixture of hot air and exhaust burner gases is forced at high speed by the blower into an insulated header pipe, which is located below the surface of the ground or ballast along the ends of the ties parallel with the track. Lateral pipes are connected to the header pipe and cross the switch between the ties just below the rails connecting on the other side of the switch to a return header pipe, which in turn is connected to the suction or intake side of the blower.

The burner is adjustable and burns from 1 to 3 gal. per hour of No. 1 or No. 2 oil (32-40 deg. Baume). Automatic-electric ignition is provided and remote control is feasible with this unit. When the switch warmer is shut off, a time switch continues the operation of the blower long enough to cool the combustion chamber and prevent the oil in the atomizing nozzle from being carbonized by the heat after the burner is shut off.

A number of advantages are claimed for this switch warmer, such as the absence of open flame; no protruding pipes or wires; dependable, easy operation, requiring only the closing of a switch, regardless of weather conditions; low upkeep cost and long life; and also that it is easy to service and operate, is easily removable, eliminates the danger of freezing up during inoperative periods and does not interfere with switching, tie renewals or ballast replacement. It is also claimed the switch warmer is highly economical, and that the high velocity of the heated gases through the pipe lines, causing a maximum of heat transference, permits efficient operation with moderate temperatures of the gases.



Diagramatic View of the Woolery Switch Heater Showing Pipe Connections from the Heater Unit and Their Arrangement Under the Switch



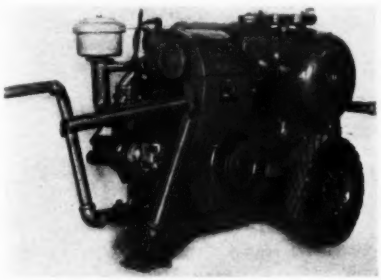
The Heater Unit, Showing Combustion Chamber, Blower and Motor Mounted on a Channel Bed

Spot Tamper Power Unit and Tamping Blade

THE Electric Tamper and Equipment Company, Ludington, Mich., has developed a spot tamper power unit, known as the WS-4, that is designed especially for small gangs doing spot tamping work and using two to four Jackson Universal Tie Tampers. It has also developed a new tamping blade for use with these tampers, known as the Jackson Step-Cut Spot Tamping blade.

The WS-4 consists of a 5-hp. four-cycle, single cylinder, gasoline engine and a generator mounted on a welded steel tube, wheelbarrow-type frame, with two pneumatic-tired front wheels and two hinged collapsible handles. The engine has forced draft air cooling, a high tension magneto with an impulse starter coupling, a counterbalanced roller bearing-mounted crankshaft, alloy steel valve seat inserts and an oil bath-type air

cleaner. The generator, which is of the self-exciting type, is driven by a triple V-belt enclosed in a shroud, is fully enclosed and has a ballbearing-mounted shaft. The capacity of the generator is two KVA of 3-phase, 110-volt, 60-70 cycle alternating current. The entire unit is unusually compact, occupying a space only 20 in. by 28 in., and weighs but 375 lb., with the weight so balanced that the lift at the handles is only 64 lb.



The WS-4 Power Unit for Operating Two to Four Jackson Tampers

The WS-4 was designed particularly for three-men section gangs using two Jackson Universal Tie Tampers although it has enough power to operate four tampers. It is small enough that it can be transported on one side of a motor car and the tampers can be placed on the other side of the car. The two front wheels give the unit added stability, lessening vibration while in use and making it easier to move along the track on the embankment shoulder. The WS-4 can be used for bridge and building work and, by means of an adapter, it is possible to obtain also 110-volt, single-phase, 60-cycle alternating current from this unit.

The new Step-Cut tamping blade developed for the Jackson Universal Tampers consists of a blade made of ¼ in. special, wear-resisting, heat treated alloy steel, which is 6½ in. wide at its widest part and 22 in.

The New Step-Cut Tamping Blade for Spot Tamping Work

long. The end of the blade is first cut at an angle of 30 deg. and this inclined portion is then notched or step cut. It is said that this blade, which was designed specially for spot tamping work, because of its spear-like point, will go quickly through tightly cemented or fouled ballast along the tie and that the "steps" gather the ballast loosened by the penetrating point and tamp it solidly, filling every void under the tie. The Step-Cut blade can also be used for the insertion and tamping of new rock or gravel ballast in moderate lifts and for such operations as skeletonizing track, renewing ties, cleaning ballast and lowering track.

New Line of Portable Air Compressors

THE Ingersoll-Rand Company, Phillipsburg, N.J., has developed a complete new line of two-stage portable air compressors available in five sizes having capacities of 85, 105, 160, 210 and 315 cu. ft. of air per minute at 100 lb. pressure. The units consist of an air-cooled, three or six-cylinder compressor, direct-connected to an engine, a steel fuel tank and a pressed steel air receiver mounted on an automotive-type chassis with a completely streamlined housing. The units are powered with a water-cooled

The New Ingersoll-Rand Two-Stage Air-Cooled Portable Compressor

Waukesha gasoline engine of the heavy-duty, industrial type or an Ingersoll-Rand heavy-duty, type H, oil engine which is designed to burn Diesel fuels.

The compressors are of the two-stage type with three or six cylinders. In the three-cylinder type, two cylinders perform the first stage of compression and the third cylinder provides the second stage. An air-cooled intercooler cools the compressed air between stages. The cylinders are arranged radially, permitting a short, rigid crankshaft and eliminating the necessity for a center bearing. The six-cylinder compressors are similarly designed, with two sets of three, radially-arranged cylinders.

All compressors are fitted with patented Ingersoll-Rand, air cushioned, channel valves and lubrication is provided by dipper pins and a constant level oil pan. The compressor crankcase is cast with a bell housing which is rigidly bolted to the engine, making the assembly one unit. A clutch of the heavy-duty, internal-expanding type, with a single screw adjustment, transmits the power from the engine to the compressor.

A number of improvements have been incorporated in this new line of compressors, including an air intake on top of the roof, insuring intake of cooler air; a stronger, sectionalized engine radiator with more rigid mounting; thermostatic control of the temperature of the radiator water; a more conveniently-located air receiver and fuel tank; improved air flow design of the compressor to reduce internal friction losses and an improved radiator-type intercooler.

The compressors are available in a wide variety of mountings, including a skid type, two wheel types for trailer use, truck mountings and four wheel mountings with steel wheels, with solid rubber tired wheels or with pneumatic tired wheels.

Jack for Pulling Spikes and Bolts

THE Buda Company, Harvey, Ill., has developed a jack which it has named the Buda Klinch Klaw, which is designed especially for pulling bolts and spikes in the decks of railroad trestles and other bridges. The jack is essentially a 15-ton ratchet jack similar to the Buda track jack of this size, except that the rack bar toe has a deep vertical slot to hold the Klaw for pulling spikes or bolts. The jack has a total height of 21⅜ in. and a rise of 13 in. The Klaw can be lowered to 9 in. below the base of the jack. With the Klaw removed, the jack can be used for any ordinary lifting, track or bridge work.

Showing Jack with Klaw in Position for Pulling Spikes or Bolts

NEWS of the Month

Townspeople Help Paint Depot

On August 12, the population of Ipswich, Mass., a town of 6000-odd people, turned out in full force to celebrate a joint venture whereby the Boston & Maine will furnish materials and the town will pay for labor from funds raised by popular subscription for repainting the depot. The people had decided that their railroad station needed a new coat of paint but had hesitated to ask the railroad to pay for such an improvement because of the present condition of railroad earnings. Negotiations resulted in the joint venture.

Southeastern Roads Reduce First Class Return Rate

Continuing their policy of reducing rates to regain traffic lost to other transportation agencies when low fares were rescinded in 1937 and 1938, carriers in southeastern passenger territory on August 31, established a round-trip fare, bearing a thirty-day limit, and good in Pullmans and parlor cars, of 2.25 cents per mile. Basic coach fares were lowered to 1.5 cents per mile on January 15 of this year and round-trip, 30-day-limit rates were lowered further on June 1 to 90 per cent of double the one-way rate.

Railroad Net Income Up

In the first seven months of 1939, Class I railroads of the United States had a net railway operating income of $214,762,841 which was at the annual rate of return of 1.66 per cent on their property investment, according to the Bureau of Railway Economics of the Association of American Railroads. This compares with a net railway operating income of $109,616,765, equivalent to a return of 0.85 per cent in the first seven months of 1938, and $450,935,427 or 3.48 per cent for the same period in 1930. The July net was $49,011,915 or 2.07 per cent, compared with $38,431,251 or 1.62 per cent in July, 1938, and $81,470,731 or 3.55 per cent in July, 1930.

Workers Administration of Mexican Railways Reorganized

As a result of criticism directed against the Workers Administration of Mexico following a series of train accidents on the National Railways of Mexico in 1938 and 1939, drastic action was taken by the railway employees at their fourth convention held recently in Mexico City, D. F. A new Workers Board, to which the railroads were turned over by a government decree on May 1, 1938, was formed, consisting of the principal railroad officers and the convention gave the Board and the general manager complete authority. It also directed that union activity jeopardizing discipline among workers and influencing the administration in the appointment of officers cease. In a further effort to establish discipline, the disciplinary committees, consisting of representatives of the union and the administration, were abolished, and the officers of the railroad were given power to apply discipline in accordance with rules and regulations. Specifically, the convention ruled that (1) the union, as sole representative of the professional interests of the workers, shall maintain its position as a resistance organization and shall continue to function in the interests of its members, and (2) the union shall support the Workers Administration and recognize its authority unless such authority is in violation of labor contracts and regulations.

Rails Ready to Handle War Traffic

After a meeting at which reports of studies begun six months ago were carefully considered, the Executive Committee of the Association of American Railroads, composed of presidents of leading railroads, expressed a unanimous opinion that the railroads as a whole could immediately handle a minimum of 25 per cent more than the present tonnage, that with the repair of equipment on hand but not now needed they could handle 50 per cent more, and that any increase beyond that point could be met by new cars and locomotives which could be made available as the need might arise. Concerning the possibility of congestion and delay at terminals, the committee stated, "Congestion and delay due to unnecessary accumulation of freight in cars at destination terminals can be prevented by means and methods adopted since 1920. This system is handled through the Association of American Railroads, a complete national organization of all essential trunk lines and many of the larger short lines, fully equipped to deal with any transportation problem, in co-operation with the railroads. In addition to improved methods of keeping equipment in movement in emergencies, the whole timing of railroad operation has been speeded up since the time of the last general car shortage, now more than fifteen years ago. Freight trains are more than 60 per cent faster, on the average, than they were in 1920, while the average output of transportation for each hour that trains are on the road has been more than doubled in the same period."

I. C. C. Study Shows Truck Costs Much Higher Than Rail

In a report on the relative costs of transportation by rail and by motor carrier of petroleum and petroleum products from California to Arizona, which included a return of 5¾ per cent upon the investment, Arthur F. White, head cost analyst and assistant director of the Interstate Commerce Commission's Bureau of Statistics, revealed costs of these two agencies of transportation which indicated that the truck costs were much higher than rail costs, varying from approximately 100 to 200 per cent higher. The cost data were presented in a case in which the trucks were requesting higher rail and truck rates in order that they might earn a fair return, and in which it was recommended that the rail rates in effect were already higher than necessary to provide reasonable minimum rates.

Rail Orders and Inquiries Since September 2

	Orders (Tons)	Inquiries (Tons)
Atlantic Coast Line	8,500	.....
Bureau of Reclamation	3,422	.....
Chesapeake & Ohio	32,000	.....
Chicago Great Western	.....	15,000
Chicago, Milwaukee, St. Paul & Pacific	.....	30,000
Chicago, Rock Island & Pacific	12,000	.....
Gulf, Mobile & Northern	1,420	.....
Illinois Central	2,000	.....
Louisville & Nashville	30,000	.....
New York Central	5,000	.....
New York, Chicago & St. Louis	7,000	.....
Pennsylvania	50,000	.....
Pere Marquette	3,000	.....
St. Louis-San Francisco	.....	10,000
Seaboard Air Line	8,512	.....
Southern	26,000	.....
Union Pacific	.....	100,000
	188,854	155,000

Association News

Railway Tie Association

The Executive Committee has voted to hold the twenty-second annual convention at the Brown Hotel, Louisville, on May 21-22, 1940.

Roadmasters Association

Following the conclusion of the convention on Thursday afternoon, September 21, President Sitton met with the Executive committee to organize the work for the year, appointing committees to pass upon amendments submitted at the convention, arrange hotel facilities, etc. The committee also made a tentative selection of chairmen who will be invited to head committees this year.

American Railway Engineering Association

Shortly after the first of the month, the secretary's office will mail to the members of the association Bulletin No. 412, which will include the reports of the Electrical section, A.A.R.; a monograph by W. M. Wilson, research professor of structural engineering, University of Illinois, on The Design of Connection Angles for Stringers of Railway Bridges; and a monograph by E. F. Wendt, consulting engineer, on Federal Valuation of Railroads.

Twelve committees held meetings during September, several in connection with the convention of the Roadmasters and Maintenance of Way Association, at Chicago, on September 19-21. These committees were as follows: Uniform General Contract Forms, at New York, on September 11; Records and Accounts, at New York, on September 19; Roadway and Ballast, at Chicago, on September 19; Maintenance of Way Work Equipment, at Chicago, on September 19; Buildings, at New York, on September 19-20; Rail, at Chicago, on September 20; Economics of Railway Labor, at Chicago, on September 20; Track, at Chicago, on September 21; Yards and Terminals, at Roanoke, Va., on September 25-26; Highways, at Chicago, on September 27; Economics of Railway Location and Operation, at New York, on September 28-29; and Rules and Organization, at New York, on September 29.

Five committees have scheduled meetings for October, these committees, together with the dates and locations of their meetings being as follows: Iron and Steel Structures, at Washington, D.C., on October 5-6; Waterways and Harbors, at Milwaukee, Wis., on October 6; Waterproofing of Railway Structures, at New York, on October 11-12; Water Service, Fire Protection and Sanitation, at Chicago, on October 18; and Wood Bridges and Trestles, at Chicago, Illinois, on October 19.

In addition to the scheduled meetings of the special and standing committees in October, the Board of Direction and the Nominating committee of the association will meet in Chicago on October 25.

Bridge and Building Supply Men's Association

Twenty-five companies have already arranged with W. S. Carlisle, secretary (care of National Lead Company, 900 West 18th street, Chicago), for space in the exhibit which will be presented concurrently with the convention of the American Railway Bridge and Building Association at the Hotel Stevens, Chicago, on October 17-19. These companies are as follows:

American Lumber & Treating Co., Chicago
Armco Railroad Sales Co., Middletown, Ohio
Buda Company, Harvey, Ill.
Celotex Corp., Chicago
Dearborn Chemical Co., Chicago
Detroit Graphite Co., Detroit, Mich.
Paul Dickinson, Inc., Chicago
Duff-Norton Manufacturing Co., Pittsburgh, Pa.
Electric Tamper & Equipment Co., Ludington, Mich.
Fairmont Railway Motors, Inc., Fairmont, Minn.
Ingersoll-Rand Co., New York
Insulite Co., Minneapolis, Minn.
Johns-Manville Sales Corp., New York
Lehon Co., Chicago
Mall Tool Co., Chicago
Massey Concrete Products Corp., Chicago
Master Builders Co., Cleveland, Ohio
National Lead Co., New York
Oxweld Railroad Service Co., Chicago
Patterson-Sargent Co., Cleveland, Ohio
Pocket List of Railroad Officials, New York
Railway Engineering and Maintenance, Chicago
Ruberoid Co., Chicago
Timber Engineering Co., Washington, D.C.
U. S. Wind Engine & Pump Co., Batavia, Ill.

Bridge and Building Association

Plans have now been completed for the forty-sixth annual convention which will be held at the Hotel Stevens, Chicago, on October 17-19, the program for which is as follows:

Tuesday, October 17

Morning Session—10 a.m.

Convention called to order.

Opening address by C. E. Johnston, chairman, Western Association of Railway Executives, Chicago.

Greetings from the American Railway Engineering Association, E. M. Hastings (chief engineer, R. F. & P.), President.

Greetings from the Roadmasters and Maintenance of Way Association, G. L. Sitton (chief engineer maintenance of way and structures, Eastern Lines, Southern, Charlotte, N.C.), President.

Greetings from the Bridge and Building Supply Men's Association, K. T. Batchelder (manager, railroad sales, Insulite Co.), President.

Address by President Armstrong Chinn (chief engineer, Alton, Chicago).

Report of Committee on The Maintenance of Shop and Enginehouse Roofs; G. S. Crites, chairman (division engineer, B. & O., Punxsutawney, Pa.)

Afternoon Session—2 p.m.

Report of Committee on Deteriorated Concrete—Causes, Detection and Methods of Repairs; S. T. Corey, chairman (assistant bridge engineer, C. R. I. & P., Chicago).

Address on Maintaining Old Masonry, by J. F. Leonard, engineer bridges and buildings, Central Region, Penna., Pittsburgh, Pa.

Report of Committee on Bridge Painting Problems Resulting from Deferred Maintenance; R. W. Johnson, chairman (asst. engr., C. M. St. P. & P., Chicago).

Tuesday Evening—8 p.m.

Moving pictures—Trees and Men—films portraying the logging and lumbering operations incident to the preparation of structural timber and lumber for use in bridge and building work, presented through the courtesy of the Weyerhaeuser Sales Company.

Wednesday, October 18

Morning Session—9:30 a.m.

Report of Committee on Glazing Maintenance in Shops and Enginehouses; F. H. Soothill, chairman (chief estimator, I.C., Chicago).

Address on Strengthening Old Bridges to Meet the Demands of Today's Traffic, by G. A. Haggander, assistant chief engineer, C. B. & Q. System, Chicago.

Report of Committee on Preframing Treated Timber for Replacement Purposes; N. D. Howard, chairman (managing editor, *Railway Engineering and Maintenance*, Chicago).

Luncheon—12:15 p.m.

Address on Current Railway Problems.

Afternoon Session—2 p.m.

Report of Committee on Pumping Equipment to Meet Today's Requirements; M. P. Walden, chairman (assistant supervisor, bridges and buildings, L. & N., Evansville, Ind.).

Address on Meeting Today's Requirements in Railway Structures, by A. T. Hawk, engineer of buildings, C. R. I. & P., Chicago.

Report of Committee on The Elimination of Slow Orders in Connection with Bridge Repair and Renewal; H. B. Christianson, chairman (division engineer, C. M. St. P. & P., Savanna, Ill.).

Wednesday Evening

Annual dinner jointly with the Bridge and Building Supply Men's Association.

Thursday, October 19

Morning Session—9:30 a.m.

Report of Committee on Present-Day Methods of Safeguarding Bridge Structures; E. C. Neville, chairman (bridge and building master, C.N.R., Toronto, Ont.).

Closing Business.

On Thursday afternoon the members will visit the new paint manufacturing plant of the Sherwin-Williams Company at Kensington (Chicago).

Personal Mention

General

J. E. Vandling, division engineer on the Pennsylvania at Pittsburgh, Pa., has been promoted to superintendent of the Erie and Ashtabula divisions, with headquarters at New Castle, Pa.

E. E. Earl, roadmaster on the Southern Pacific at Los Angeles, Cal., has been appointed construction superintendent, with headquarters at Redding, Cal., in connection with the relocation work.

Herman T. Frushour, superintendent of the Long Island at Jamaica, N. Y., and an engineer by training and experience, has been promoted to general superintendent of the Western Pennsylvania division of the Pennsylvania, with headquarters at Pittsburgh, Pa. Mr. Frushour was born at Logansport, Ind., on February 17, 1882, and graduated from Purdue University.

Herman T. Frushour

During the summer vacations, he secured temporary employment with the Pennsylvania as a rodman and locomotive fireman. In September, 1902, after graduation, he entered this road's service as a rodman on the Logansport division and was advanced to assistant on engineering corps in May, 1907. Mr. Frushour was appointed division engineer on the Cleveland and Pittsburgh division (now called the Cleveland division) in January, 1927, and became superintendent of the Monongahela division at Uniontown, Pa., in July, 1928. He was transferred to the Erie and Ashtabula division at New Castle, Pa., in June, 1929; to the St. Louis division at Terre Haute, Ind., in September, 1932; and to the Eastern division at Pittsburgh, in July, 1933. Mr. Frushour became superintendent of the Long Island at Jamaica, N. Y., in November, 1935.

William K. Tate, assistant to president of the Nashville, Chattanooga & St. Louis, and an engineer by training and experience, has been promoted to assistant vice-president-traffic, with headquarters as before at Nashville. Mr. Tate was born at Tyler, Tex., on January 13, 1898, and attended Vanderbilt University, Nashville. He entered railway service on March 13, 1917, with the N. C. & St. L. as a draftsman in the engineering department, later serving as instrumentman and topographer

William K. Tate

on a survey party. On January 1, 1918, he was advanced to assistant division engineer on the Huntsville division with headquarters at Tullahoma, Tenn., holding this position until October 1, 1918, when he volunteered for service in the United States Army, serving at the Officers Training Camp at Fort Monroe, Va. On December 1, 1918, he returned to his former position with the N. C. & St. L. at Tullahoma, and on March 16, 1929, he was promoted to industrial engineer in the industrial and public relations division of the traffic department, with headquarters at Nashville. On January 1, 1935, he was placed in charge of the industrial and public relations division, with the same title, and, in the spring of 1936, he was appointed assistant to the vice-president and traffic manager. Mr. Tate was further advanced to assistant to the president, with headquarters as before at Nashville, in August, 1937, holding that position until his recent promotion.

Robert B. Ball, assistant general manager of the Gulf, Colorado & Santa Fe, with headquarters at Galveston, Tex., and

Robert B. Ball

an engineer by training and experience, has been promoted to vice-president and general manager, with the same headquarters. Mr. Ball was born in Randolph County, Mo., on December 17, 1880, and graduated from Leland Stanford University in 1904. Previous to graduation, Mr. Ball served for a year in the engineering department of the Coast lines of the Santa Fe. In 1904, he re-entered the service of this company as an instrumentman, being advanced to division engineer in 1910. Two years later, Mr. Ball was promoted to district engineer, with headquarters at Los Angeles, Cal., and in 1918, he was further promoted to chief engineer of the Coast lines. In 1929, he was transferred to Chicago as assistant chief engineer of the system, and on July 1, 1936, he was advanced to assistant general manager of the Gulf, Colorado & Santa Fe, with headquarters at Galveston.

Charles H. Buford, general manager of the Western lines of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Seattle, Wash., and an engineer by training and experience, has been elected vice-president in charge of operations and maintenance of the Association of American Railroads, with headquarters at Washington, D. C.

Mr. Buford graduated in civil engineer-

Charles H. Buford

ing from the University of Arkansas in 1907 and immediately entered railway service as an instrumentman in the engineering department of the Milwaukee. In 1908, he was appointed a draftsman in the bridge department at Chicago. In 1910, he went with the Atchison, Topeka & Santa Fe as a designing and estimating engineer in the office of the chief engineer at Chicago, and in 1913, he returned to the Milwaukee as assistant engineer on the Chicago track elevation work and was subsequently promoted to engineer of track elevation at Chicago. In April, 1917, he was promoted to trainmaster of the Sioux City and Dakota division, with headquarters at Sioux City, Iowa, and in February, 1918, he was transferred to the LaCrosse division, with headquarters at Milwaukee, Wis. Mr. Buford was advanced to superintendent of the Wisconsin Valley division, with headquarters at Wausau, Wis., in July, 1918. He later served as division superintendent at Green Bay, Wis., Sioux City, and Terre Haute, Ind. He was promoted to general superintendent, Southern district, with headquarters at Chicago, in October, 1924, and on November 15, 1925, he was further

advanced to assistant general manager of the Eastern lines, with the same headquarters. Mr. Buford was promoted to general manager of the Western lines, with headquarters at Seattle on November 1, 1927, holding that position until his recent appointment.

John M. Ryan, division engineer of the Nashville and P & M divisions of the Nashville, Chattanooga & St. Louis, with headquarters at Nashville, Tenn., has been promoted to assistant to general manager, with the same headquarters, succeeding **R. L. Schmid,** whose promotion to principal assistant engineer, with the same headquarters, is announced elsewhere in these columns.

Engineering

H. B. Reinsagen, assistant chief engineer of the Ohio Central lines of the New York Central, with headquarters at Cleveland, Ohio, retired on October 1.

L. L. Lyford, office engineer of the Illinois Central, with headquarters at Chicago, has been appointed assistant to chief engineer, with the same headquarters, a change in title.

J. G. Sutherland, division engineer on the Canadian Pacific at Schreiber, Ont., has been transferred to the Smiths Falls division, with headquarters at Smiths Falls, Ont., succeeding **J. R. Caswell,** transferred.

I. L. Pyle, assistant chief engineer of the Chesapeake & Ohio, with headquarters at Richmond, Va., has been appointed chief engineer, succeeding **Charles W. Johns,** whose death on September 16, at Clifton Forge, Va., is announced elsewhere in these columns.

John B. Whiting, master carpenter on the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., has been promoted to division engineer, with headquarters at Des Moines, Iowa, succeeding **L. J. Hughes,** who has been transferred to Chicago.

T. M. von Sprecken, supervisor of bridges and buildings on the South end of the Cincinnati, New Orleans & Texas Pacific (part of the Southern), with headquarters at Somerset, Ky., has been promoted to engineer of bridges, Western lines, with headquarters at Cincinnati, Ohio, relieving **G. H. Gilbert,** who has retired because of ill health.

Following the recent consolidation of the engineering and maintenance of way departments of the Delaware & Hudson under **P. O. Ferris** as chief engineer, as reported in the August issue, several additional changes in the personnel of the engineering department have been made, which became effective on August 16. **C. E. R. Haight,** formerly office engineer in the office of the engineer maintenance of way, has been appointed to the newly created position of engineer of track. **E. Penrose,** engineer of bridges, has had his title changed to engineer of structures, and **A. R. Morse,** grade crossing engineer, has had his title changed to construction engineer. **J. P. McAvoy,** valuation engineer, has been appointed office engineer in the chief engineer's office, and the position of valuation engineer has been abolished. All these officers have headquarters at Albany, N. Y.

R. L. Schmid, assistant to the general manager of the Nashville, Chattanooga & St. Louis, has been promoted to principal assistant engineer, with headquarters as before at Nashville, Tenn., a newly created position, and **Otto Joslin,** bridge and building supervisor, has been promoted to senior assistant engineer at Nashville, succeeding **Charles H. Brodbeck,** who has been appointed division engineer of the Nashville and P & M divisions, with headquarters at Nashville, replacing **John M. Ryan,** whose promotion to assistant to the general manager at Nashville, relieving Mr. Schmid, is announced elsewhere in these columns. **W. H. Lord,** assistant engineer, Chattanooga and Atlanta divisions, has been promoted to assistant division engineer of those divisions, with headquarters at Chattanooga, Tenn., and **E. G. Talley,** assistant engineer, Nashville and P & M divisions, has been promoted to assistant division engineer of those divisions, with headquarters at Nashville, Tennessee.

Track

A. L. Kleine, track inspector on the Denver & Rio Grande Western at Dotsero, Colo., has been promoted to roadmaster at Helper, Utah, replacing **H. J. Willard,** who has been transferred to Grand Junction, Colo., succeeding **R. A. Fox.**

L. B. Craig has been appointed track supervisor on the St. Louis division of the Southern, with headquarters at Huntingburg, Ind., succeeding **C. C. Mullen,** who has been transferred to Tuscaloosa, Ala., replacing **J. M. Boles,** who has been transferred to Lexington, Ky., relieving **S. B. Hinton, Jr.**

G. M. Rowe has been appointed roadmaster on the Southern Pacific at Los Angeles, Cal., succeeding **E. E. Earl,** whose appointment as construction superintendent at Redding, Cal., is announced elsewhere in these columns. **S. E. Gordon,** roadmaster at Truckee, Cal., has been transferred to Oakland Pier, Cal., succeeding **V. E. Pearson,** who has been transferred to Truckee replacing Mr. Gordon.

C. I. Parsons, assistant supervisor of bridges and buildings on the Alabama Great Southern (part of the Southern), with headquarters at Birmingham, Ala., has been promoted to track supervisor on the St. Louis division at Princeton, Ind., succeeding **J. R. Brosnan,** who has been transferred to Dayton, Tenn. Mr. Brosnan replaces **J. P. Mumford,** who has been transferred to Chattanooga, Tenn., relieving **A. H. Exon,** whose promotion to supervisor of bridges and buildings at Somerset, Ky., is announced elsewhere in these columns.

R. B. Johnson, roadmaster on the Chicago & North Western at Chadron, Neb., has been transferred to Fremont, Neb., replacing **W. H. Bentz,** who has been transferred to Chadron. **A. W. Hyland** has been appointed roadmaster at Norfolk, Neb., succeeding **W. E. Reid,** who has been assigned to other duties. Subdivision No. 3, formerly under the jurisdiction of **H. T. Anderson,** roadmaster at Fremont, Neb., has been consolidated with other sub-divisions on the Nebraska division, and Mr. Anderson has been assigned to other duties.

Junius E. Griffith, whose promotion to trainmaster on the Southern, with headquarters at Charleston, S. C., was announced in the September issue of *Railway Engineering and Maintenance,* was born on December 3, 1902, at Charlotte, N.C. From September 15, 1922 to June 1, 1926, he attended North Carolina State College, and then to May 1, 1927, was engaged in civil engineering work at Charlotte and Greenville, S.C. On May 1, 1927, he entered the service of the Southern as a junior engineer, serving with the engineer maintenance of way at Charlotte. He subsequently served for a short time as a transitman and then again as junior engineer, and from August, 1928 to October, 1930, as junior engineer and student apprentice. He was then appointed assistant supervisor of track, and from February, 1932 to the following July, served as supervisor of track. Mr. Griffith then resumed his duties as assistant supervisor of track until his appointment in May, 1933, as supervisor of track at Keysville, Va. From June, 1935, he served as supervisor of track at Charlottesville, Va., until his recent appointment as trainmaster at Charleston.

Alex J. G. Murdoch, whose retirement as roadmaster on the Canadian Pacific, with headquarters at Assiniboia, Sask., was announced in the September issue, of *Railway Engineering and Maintenance* was born at Colombo, Ceylon, on January 8, 1878, and entered railway service in July, 1905, as a train caller at Winnipeg, Man., for the Canadian Pacific. The following year he transferred to the construction department and served as a timekeeper and later as a rodman on the Kootenay Central Railway (now part of the Canadian Pacific) at Golden, B. C. He later served in various capacities, including those of draftsman, material yard foreman and general construction foreman in British Columbia, Saskatchewan and Manitoba. Mr. Murdoch enlisted in the Canadian Overseas Railway Construction Corps in 1915, and was later promoted up through the ranks to lieutenant. In October, 1919, he returned to the construction department of the Canadian Pacific as clerk to the construction superintendent at Lanigan, Sask. In 1921, he was made a section foreman and in 1923, he was promoted to roadmaster on the Moose Jaw division, with headquarters at Assiniboia, the position he held until his retirement.

Bridge and Building

Dave Ruhl has been appointed general building inspector of the Chicago, Rock Island & Pacific with headquarters at Chicago, a newly created position.

W. C. Roach has been appointed acting bridge and building supervisor of the Atlanta division of the Nashville, Chattanooga & St. Louis, with headquarters at Calhoun, Ga., succeeding **Otto Joslin,**

whose promotion to senior assistant engineer at Nashville, is announced elsewhere in these columns.

T. J. Webster, bridge and building foreman on the Missouri-Kansas division of the Chicago, Rock Island & Pacific, has been promoted to master carpenter with headquarters at Kansas City, Mo., succeeding **John B. Whiting,** whose promotion to division engineer, with headquarters at Des Moines, Iowa, is announced elsewhere in these columns.

A. H. Exon, track supervisor on the Southern at Chattanooga, Tenn., has been promoted to supervisor of bridges and buildings, with headquarters at Somerset, Ky., succeeding **T. M. von Sprecken,** whose promotion to engineer of bridges, Western lines, with headquarters at Cincinnati, Ohio, is announced elsewhere in these columns, and **H. L. Veith** has been appointed assistant supervisor of bridges and buildings at Birmingham, Ala., succeeding **C. I. Parsons,** whose promotion to track supervisor at Princeton, Ind., is announced elsewhere in these columns.

David H. Johnson, bridge and building foreman on the Chicago, St. Paul, Minneapolis & Omaha, has been promoted to supervisor of bridges and buildings, with headquarters at St. Paul, Minn., succeeding **Tollef Hansen Thompson,** whose death on June 16 is announced elsewhere in these columns.

Mr. Johnson was born at Clear Lake, Wis., on September 12, 1895, and entered railway service on March 5, 1915, on the Northern Pacific. In 1917, he went with the Omaha as a bridge and building carpenter and on August 25, 1924, he was promoted to bridge and building foreman, the position he held until his recent promotion.

George E. Brooks, whose retirement as master carpenter on the Chicago, Rock Island & Pacific, with headquarters at Rock Island, Ill., was announced in the September issue, was born at Canandaigna, N. Y., on July 11, 1879, and entered the service of the Rock Island on March 4, 1900, as a carpenter on the Nebraska division. On March 1, 1902, he was promoted to bridge and building foreman on that division and on November 1, 1905, he resigned to enter other business. Mr. Brooks re-entered the service of the Rock Island on January 5, 1913, as a bridge and building foreman at Rock Island, and in May, 1917, he was advanced to master carpenter on the Illinois division, with the same headquarters. On April 1, 1933, the position of master carpenter was abolished and he was appointed bridge and building foreman and on April 6, 1936, he was again made master carpenter of the Illinois and Chicago terminal divisions, the position he held until his retirement.

Special

L. Clyde Hazlett, whose promotion to chief tie inspector of the Missouri-Kansas-Texas, with headquarters at Parsons, Kan., was announced in the August issue of *Railway Engineering and Maintenance*, was born at St. Paul, Ark., on August 25, 1895, and attended college in 1915 and 1916. He entered railway service in June, 1917, as a tie inspector on the Union Pacific, and on February 15, 1919, he went with the Katy as tie and timber inspector, holding that position until his recent promotion to chief tie inspector.

Obituary

Charles W. Johns, chief engineer of the Chesapeake & Ohio, with headquarters at Richmond, Va., died on September 16 at Clifton Forge, Va., from a cerebral hemorrhage. He was 63 years old.

Elmer E. Turner, retired roadmaster on the Missouri-Kansas-Texas, died at his home in Jefferson City, Mo., on August 16, following a heart attack. Mr. Turner was born at Panola, Ill., on January 31, 1864, and was first employed in railway service on the Illinois Central at Dubuque, Iowa. He later became a Katy roadmaster, and served at various points in Texas, including San Antonio. On March 25, 1929, he was granted a leave of absence and later retired.

T. J. Skillman, chief engineer-consultant of the Pennsylvania, with headquarters at Philadelphia, Pa., died on September 24, at his home in Ardmore, Pa., at the age of 62. Mr. Skillman was

T. J. Skillman

born in Trenton, N.J., on November 6, 1876, and was graduated from Princeton University in 1898 with a degree in civil engineering. He entered the service of the Pennsylvania at Jersey City, N.J., in March, 1899, as a blue-print boy and four months later was appointed rodman on an engineering corps. He became division engineer at Cape Charles, Va., in June, 1913, and a year later was transferred to Camden, N.J., in the same capacity. In April, 1917, Mr. Skillman was appointed division engineer of the Monongahela division at Pittsburgh and on July 7 of that year was assigned to a special study of terminal developments at New York. In March, 1920, he was appointed chief engineer maintenance of way of the Western region, with headquarters at Chicago, and in July, 1926, was transferred to the Long Island as chief engineer. On February 1, 1927, Mr. Skillman was appointed chief engineer of the Pennsylvania system, with headquarters at Philadelphia. He was granted a leave of absence in October, 1935, on account of ill health, and a year later was appointed chief engineer-consultant.

Tollef Hansen Thompson, supervisor of bridges and buildings on the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at St. Paul, Minn., died of heart disease on June 16. Mr. Thompson was born in Norway on November 11, 1886, and entered railway service on July 11, 1907, as a carpenter helper on the Omaha, later being promoted to carpenter. From 1912 to 1917, he worked intermittently as bridge foreman and pile driver engineer until he was appointed scale inspector for the system in September, 1917. In February, 1923, he was appointed supervisor of bridges and buildings, with headquarters at Worthington, Minn. Mr. Thompson was re-appointed scale inspector, with headquarters at St. Paul, in January, 1932, and in February, 1938, he was made supervisor of bridges and buildings, with the same headquarters, the position he held at the time of his death.

Harold M. Swope, division engineer on the Atchison, Topeka & Santa Fe, with headquarters at Emporia, Kan., died at the Santa Fe hospital in Topeka, Kan., on September 13. Mr. Swope was born at Emporia, Kan., on December 1, 1891, and entered railway service on November 23, 1913, as a rodman in the engineering department of the Santa Fe at Topeka. In July, 1914, he was appointed a masonry inspector and two months later he was promoted to transitman. On June 1, 1917, he was advanced to office engineer at Marceline, Mo., and from January 1, 1918, to April 15, 1918, he was granted a leave of absence because of ill health. Mr. Swope returned to service on the latter date as a transitman at Las Vegas, N. M., and later served in that capacity at San Marcial, N. M., and Topeka. On March 1, 1921, he was promoted to office engineer at Topeka and six years later he was advanced to division engineer with headquarters at Emporia. On November 1, 1938, his territory was extended to include the Kansas City division.

Frederick Erving Rice, who retired on September 15, 1937, as assistant engineer on the Chicago, Milwaukee, St. Paul & Pacific at Minneapolis, Minn., died in Whinlock, Wash., on September 4. Mr. Rice was born at Rutland, Vt., on December 21, 1857, and graduated from Carleton College, Northfield, Minn. He entered railway service in 1882, in the engineering department of the Milwaukee, and later served on the construction of lines from Glencoe, Minn., to Hutchinson; from Northfield, Minn., to Red Wing; from Andover, S.D., to Brampton, N.D., and from Aberdeen, S.D., to Edgeley, N.D. In 1901 and 1902, Mr. Rice was placed in charge of the reconstruction of the "Short Line" bridge over the Mississippi river between Minneapolis and St. Paul, Minn., and from 1906 to 1908, he was resident engineer at Pontis, S.D. (now Mobridge) in charge of the construction of the Missouri River bridge. In 1908, he was promoted to district carpenter, with headquarters at Minneapolis, and in 1921, he was appointed assistant engineer, with the same headquarters, holding that position until his retirement.

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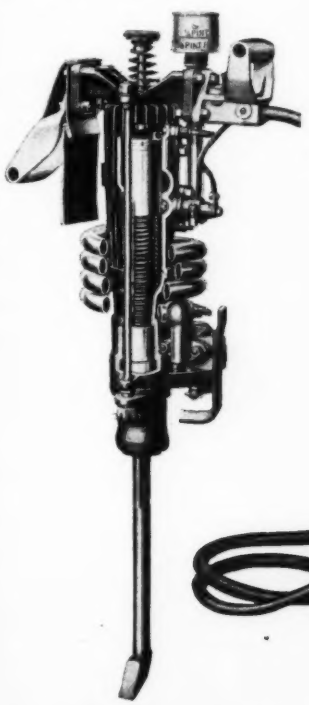

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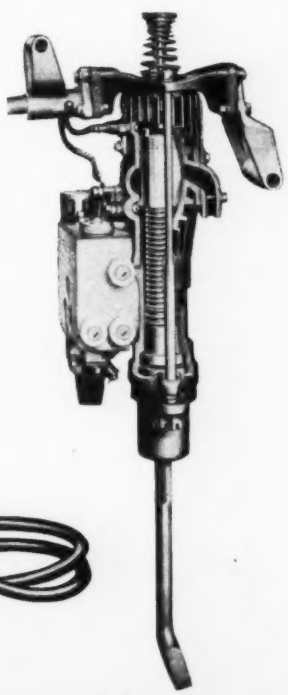

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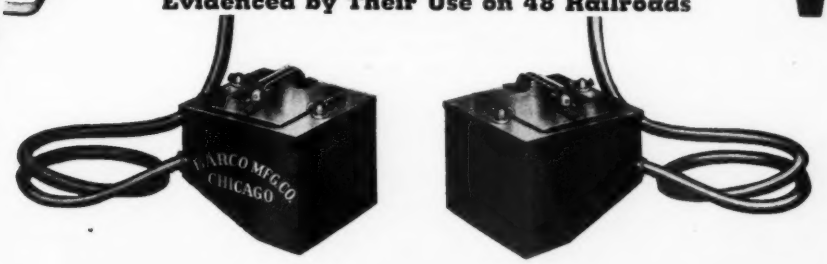

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Supply Trade News

General

The Wood Preserving Corporation, Pittsburgh, Pa., a subsidiary of the **Koppers Company,** has purchased the tie producing business of **B. Johnson and Sons,** Richmond, Ind.

The directors of the **Union Carbide & Carbon Corporation,** New York, have approved an agreement for the acquisition by Carbide of all the assets of the **Bakelite Corporation,** New York.

The Hobbs-Western Company, St. Louis, Mo., has purchased the tie producing operations of the **Tennessee Tie Company,** along the lines of the Nashville, Chattanooga & St. Louis in Tennessee, and along the lines of the Southern in Kentucky and Tennessee, and will conduct the business under the name of the Hobbs-Western Company.

Personal

W. E. Hicks has relinquished his interest in and resigned as president and director of the **American Railway Excavators, Inc.,** St. Louis, Mo., and has established a new company, the **W. E. Hicks Construction Company,** St. Louis, Mo.

L. T. Johnston, vice-president of the **Armco Railroad Sales Company,** with headquarters at Middletown, Ohio, has been elected president and general manager of that company, with the same headquarters, and **E. T. Cross,** formerly general manager of the **Ingot Iron Railway Products Company** (whose railroad sales were taken over by the Armco Railroad Sales Company on July 1), with headquarters at Middletown, has been elected assistant general manager of the Armco Railroad Sales Company, with headquarters, as before, at Middletown.

Wood Sanford, district sales manager in the North Central Territory for the Chain Belt Company, Milwaukee, Wis.,

Wood Sanford

has been appointed sales engineer in the railway division of the **Buda Company,** with headquarters at Harvey, Ill. Following graduation from Purdue University in 1922, Mr. Sanford went with the Sullivan Machinery Company, Michigan City, Ind., and served in various departments including engineering, manufacturing, research, sales and service. From the Sullivan Machinery Company, Mr. Sanford went with the Harnischfeger Corporation, Milwaukee, and later with the Chain Belt Company in that city.

Avery C. Adams, vice-president and assistant general manager of sales for the Inland Steel Company, at Chicago, has been elected vice-president in charge of sales and a member of the executive committee and board of directors of the **United States Steel Corporation of Delaware,** with headquarters at Pittsburgh, Pa., succeeding **C. V. McKaig,** who becomes assistant to president, with duties as may be assigned. Mr. McKaig continues as a member of the executive committee and board of directors. A biographical sketch of Mr. Adams' career, accompanied by a photograph, was published in the January issue of *Railway Engineering and Maintenance* following his election as vice-president and assistant general manager of sales of the Inland Steel Company.

William A. Ross, vice-president and general manager of sales of the **Columbia Steel Company,** San Francisco, Cal., has

William A. Ross

been elected president, to succeed **Ambrose N. Diehl,** who has resigned because of ill health. Mr. Ross has been connected with the steel industry since 1895, when he entered the employ of the Washburn Moen Manufacturing Company as an office boy. In 1899, this company was acquired by the American Steel & Wire Company, and Mr. Ross served the new firm as bill clerk and cashier. In 1911, the west coast holdings of the American Steel & Wire Company became the Pacific Coast department of the United States Steel Products Company, a subsidiary of the United States Steel Corporation, and upon this consolidation Mr. Ross was appointed assistant treasurer and then assistant to the vice-president of the products company. In 1930, the Columbia Steel Corporation was acquired by the United States Steel Corporation. The Pacific Coast department of the United States Steel Products Company was then consolidated with the new enterprise under the name of the Columbia Steel Company, with Mr. Ross serving as vice-president and treasurer. By 1932, he was appointed vice-president and general manager of sales, which position he has held until his recent election.

In 1899, Mr. Diehl entered the employ of the Carnegie Steel Company as a chemist in the laboratory of the Duquesne works. After holding various positions, he became assistant general superintend-

A. N. Diehl

ent of the Duquesne works in 1915 and operating vice-president in charge of the Pittsburgh district of the Carnegie Steel Company in 1918. In 1930 he was made vice-president of the United States Steel Corporation, and in 1932, was elected president of the Columbia Steel Company.

Obituary

Charles M. Schwab, chairman of the board of the Bethlehem Steel Corporation, following ill health for some time, died of coronary trombosis at the age of 77, on September 18, at his home in New York. Mr. Schwab was born at Williamsburg, Pa., on February 18, 1862, and entered the service of the Carnegie Company as a stake-driver in the engineering corps of its Edgar Thompson Steel Works. By studying chemistry in a home laboratory and pioneering in the early stages of metallurgy, Mr. Schwab advanced rapidly, becoming chief engineer of the Edgar Thompson Works at the age of 19, and superintendent of Andrew Carnegie's Homestead plant at the age of 25. Two years later he became general superintendent of the Edgar Thompson Works, and in 1892, his jurisdiction was extended to include the Homestead plant. In 1897, he was appointed president of the entire Carnegie Steel Company, Ltd. During the next few years, Mr. Schwab was active in the development of the United States Steel Corporation, of which he was made president in 1901. He resigned in 1903 to organize his own steel enterprise, which resulted in the organization of the Bethlehem Steel Corporation. After the armistice, he placed Bethlehem in the hands of Eugene Grace, its president since 1916, but continued to advise as chairman until his death. Under Mr. Schwab, Bethlehem has contributed much to the railway industry. In 1907, he was a leader in a movement by steel producers to roll steel rails to approved standards, and in 1916, under his direction, Bethlehem took over the Pennsylvania Steel Company, specialists in rail production.

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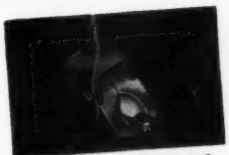

1. The open jaws are put in place.

2. Leverage closes jaws, grasps spike and pulls.

3. Repeated bites and leverage extract spike straight out.

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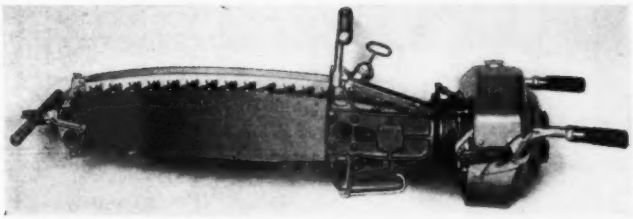

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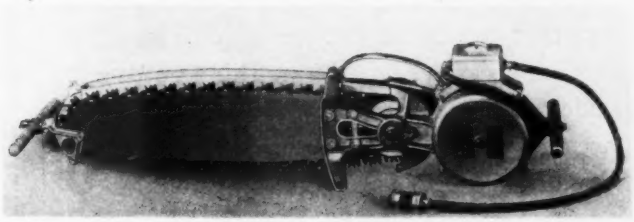

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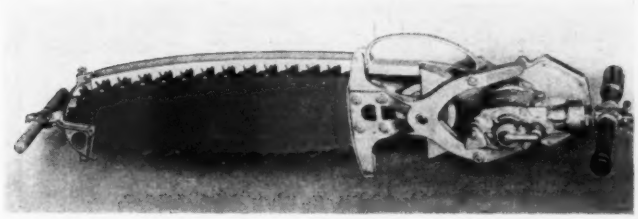

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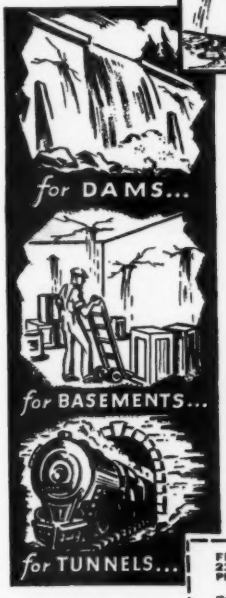

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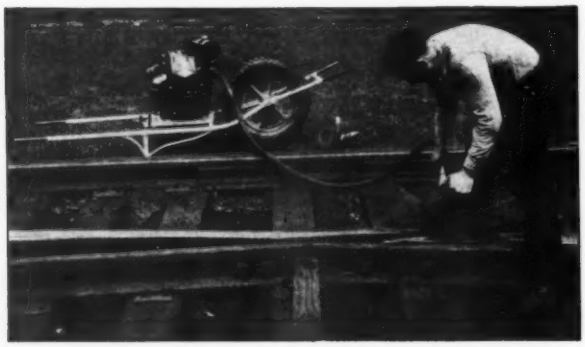

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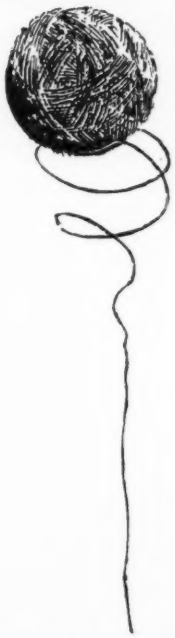

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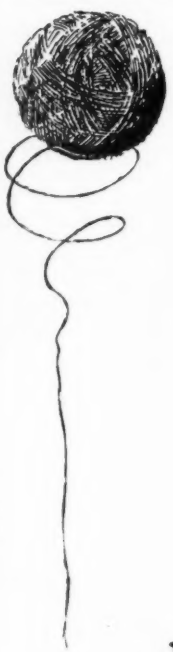

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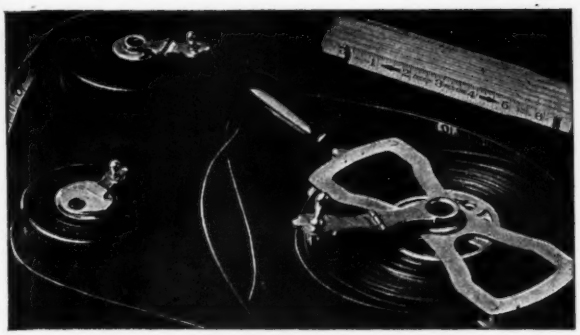

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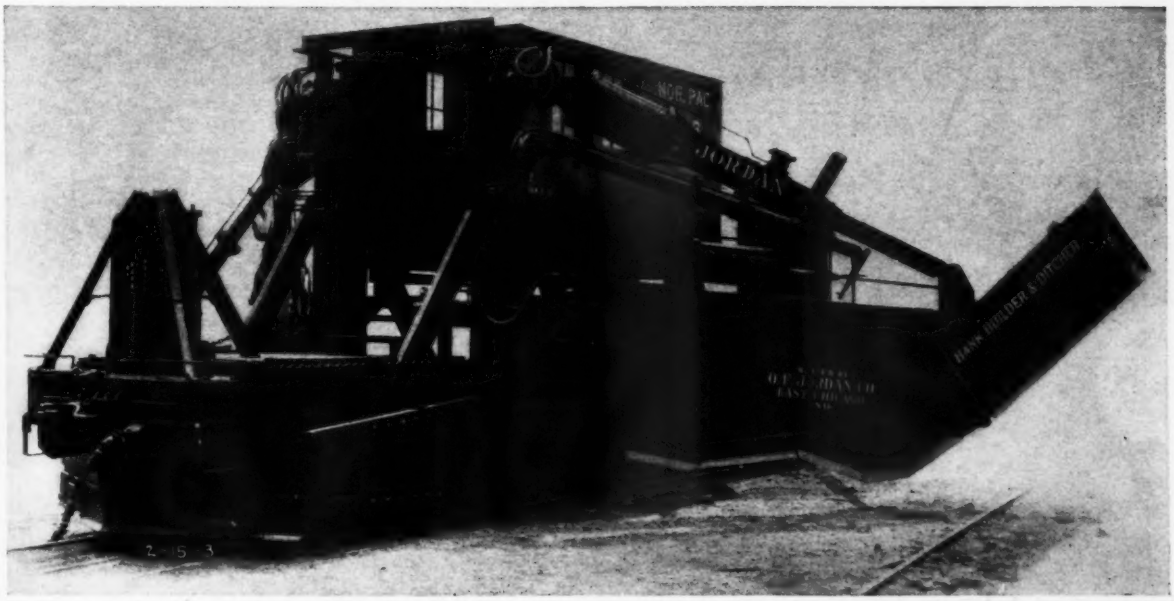

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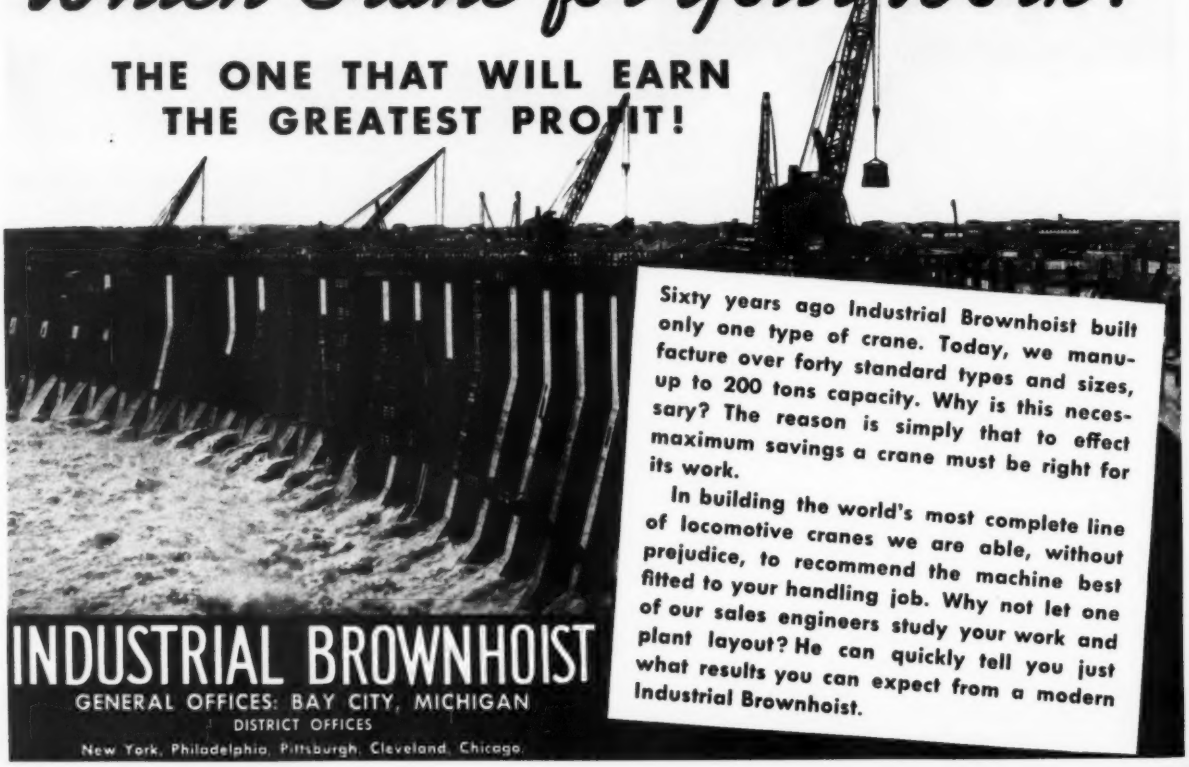

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5. **Each and every clip functions uniformly.**
6. ***Fit all tie plates single or double shouldered and all rail sections.***
7. **Applied extensively on existing and new rail, at switches, crossings, bridges, turntables, etc.**
8. **Compression Spring Clips in service on many railroads with number per rail varying to meet conditions.**